Division of Aquatic and Wildlife Resources

Guam Department of Agriculture

Annual Report Fiscal Year 1996

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'96

ANNUAL REPORT
FISCAL YEAR 1996

DIVISION OF AQUATIC AND WILDLIFE RESOURCES
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PERIOD COVERED:
October 1, 1995 to September 30, 1996

Guam Aquatic and Wildlife Resources Annual Report FY'96

ACKNOWLEDGEMENTS

The Division of Aquatic and Wildlife Resources, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

Members of the Guam Fishing & Boating Association, the Marianas Fishing Derby Committee and the manager of the Guam Fishermens's Coop for allowing fishery biologists to examine their fish;

Fishermen who have cooperated with fishery data collection;

Individuals who have reported poaching activities and bird sightings;

Hunters who have cooperated with wildlife data collection by filling out and returning hunter questionnaires;

Base Commanders of the U.S. Ordnance Annex (formerly Naval Magazine), Naval Station, Naval Computer and Telecommunications Master Station, and Andersen Air Force Base;

Security Officers and their staffs at the U.S. Ordnance Annex (formerly Naval Magazine), Naval Computer and Telecommunications Master Station, and Andersen Air Force Base;

Staff and management of KGTF Channel 12;

Print and electronic media for coverage of our programs and activities and for their support of conservation education programs;

Personnel of the Naval Oceanographic Command Detachment for providing weather data;

The Marine Lab, University of Guam;

Personnel from the Office of Enforcement, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce;

Personnel from the Division of Law Enforcement, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

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JOB PROGRESS REPORT
COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-3C-4
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs (1630, 2630)

PERIOD COVERED: October 1, 1995 to September 30, 1996

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration and endangered species programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.

2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.

3. Administer all personnel matters including recruitment of off-island staff.

4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division experienced several staff changes during the year, and has suffered a net loss of staff:

Administration: Assistant Chief Robert D. Anderson was promoted to Division Chief in May 1996. Administrative Officer Alan Van Aken joined the staff in July 1996. Word Processing Secretary II Nancy Mafnas resigned in November 1995. Public Information Officer Lillian Mariano resigned in August 1996. Arlene Tedtaotao was promoted to Secretary Typist I in February 1996. Lillian Rebanio joined the staff in February 1996, initially as a trainee through the Work Experience Program sponsored by the Department of Public Health and Social Services, and then as a Clerk I in September 1996.

Wildlife: Biologist I Sean Slappy joined the staff in July 1996 to work on the brown tree snake program. Wildlife Technician II Jesse Guerrero resigned in June 1996. Wildlife Biological Aide Franklin Cruz was promoted to Technician I. Jesse Taijeron joined the staff in February 1996 as a trainee through the Work Experience Program sponsored by the Department of Public Health and Social Services.

Fisheries: Biologist II Wayne Kruckenberg was promoted to Biologist III in October 1996. Technician I George Mendiola transferred to the Plant Protection and Quarantine Division in July 1996.

Law Enforcement: There were no staff changes during FY96.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY95 under its various federal programs and submitted them to the U.S. Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY97. This documentation included annual Grant Agreements for 1) Project FW-3C, Guam Fish and Wildlife Coordination, which covers the administration and coordination of the Division's Federal Aid programs and which is jointly funded by wildlife (PR) and sport fisheries (DJ) funds; 2) Project F-1R, Guam Sport Fish Investigations, which covers sport fish research and survey activity and which is funded with sport fisheries (DJ) funding; and 3) Project W-1R, Guam Wildlife Investigations, which covers wildlife research and survey activity and which is funded with wildlife (PR) funds. In addition, annual Grant Agreements and Amendments were prepared for the Division's various Fisheries Development and Endangered Species Investigations (Section 6) projects. A Grant Proposal and Agreement was also prepared and submitted for a pumpout grant.

The Division's funding proposal for the allocation of FY96 Section 6 Endangered Species Conservation Program grant funds was approved by the Fish and Wildlife Service, and funded at $448,950, a significant increase over past years.

The request to amend the Division's Endangered Species Sub-permit to allow for the translocation of a limited amount of genetic material (Mariana crow eggs and/or chicks) from Rota to Guam remained on hold pending completion of a report on *The Scientific Bases for Preservation of the Mariana Crow* by a select committee appointed by the National Research Council under commission by the Fish and Wildlife Service. The Committee met on Guam in May. The report, which was received at the very end of fiscal year, recommended release on Guam of the twelve Mariana crows currently in captivity on Guam (2 crows) and in mainland zoos (10 crows) rather than translocation of genetic material from Rota.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

The Division's administration and coordination responsibilities are 50% funded by local funds.

The Chief served on the Area Committee for Oil Spill Response and he is a member of the Criminal Justice Advisory Committee at Guam Community College. The Chief supervised the locally-funded Technical Assistance Program, staffed by Biologist II Marvin Aguilar and continued to serve as a member of the Technical Advisory Committee for the I Tano'ta Land Use Plan being developed by the Territorial Planning Council. He also served as a member of the Technical Review Committee (now Rehabilitation Advisory Board [RAB]) for the Andersen Air Force Base Institution Restoration Program (IRP) as well as for Naval installations other than Naval Air Station.

The Division participated in a series of meetings with the Department of Parks and Recreation, the Chamorro Land Trust Board, and the Bureau of Planning to review the inventory of Government of Guam lands to determine which have the best potential for incorporation into the Territorial Park System as Conservation Areas in accordance with the mandate of PL 22-18, which requires that the two Departments (Agriculture and Parks)

develop a comprehensive master plan before any additional lands are so designated. A draft plan was completed and being reviewed at the end of the report period.

The Chief, Fisheries Supervisor, and Wildlife Supervisor serve as members of the Area Committee's Oiled Wildlife Cleanup Subcommittee, which was established to review current cleanup techniques for inclusion in the Area Plan.

Because the Occupational Safety and Health Administration requires a certain level of hazardous materials training for all persons involved in an oil spill response, the Coast Guard provided an 8-hour HAZMAT recertification training to a number of Division staff who completed a 40-hour Hazardous Waste Operations (HAZWOPER) course the previous year.

Division staff made a number of off-island trips related to Federal Aid and other programs:

The Division Chief represented the Division at the initial meeting of the National Research Council's Committee on the Scientific bases for Preservation of the Mariana Crow in Honolulu in April and he attended a meeting of Federal Aid Directors and Chiefs October 10-12, 1995 in Honolulu, Hawaii.

The Division Chief attended the 1995 Federal Aid Coordinators Conference held in Seattle, Washington in October 1995. The Division Chief attended a training course entitled "Cost Principles for State, Local and Indian Tribal Governments: OMB Circular A-87", April 16-18 in Reno, Nevada. The training course was sponsored by Region 1 of the Fish and Wildlife Service.

Fisheries Supervisor Gerald W. Davis attended the two-day Federal Aid workshop in Honolulu discussing the eligibility of various activities under the Sport Fish Restoration Program. He also attended the 63rd meeting of the Scientific and Statistical Committee on the Western Pacific Fisheries Management Council, held on Molokai in August.

Biologist III Andrew Torres attended the Bottomfish Plan Monitoring Team meetings in Honolulu, Hawaii in March and July, funded by the Western Pacific Regional Fisheries Management Council. Fisheries Biologist I Tom Flores attended the Pelagic Plan Monitoring Team meetings in Honolulu in March and July funded by the Western Pacific Regional Fisheries Management Council. Biologist III Kelly Brock and Wildlife Biologist II Grant Beauprez made numerous trips to Rota in support of the Rota Rail Introduction Project. In addition to radio telemetry monitoring of released rails, they conducted rodent and predator trapping. Biologist III Celestino Aguon and Biologist III Gary Wiles assisted the National Biological Service in conducting bridled white-eye surveys on Rota in September 1996. The Division hosted a number of off-island visitors during the year.

PROGRAM COST

The estimated cost of the Coordination/Administration project was $65,000.

This report was prepared by: Robert D. Anderson

JOB PROGRESS REPORT
INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-3C-4
SUB-PROJECT NO.: C-3
JOB NO.: 1

JOB TITLE: Public Information and Education on Guam's Fish and Wildlife Restoration and Endangered Species Programs (2520, 2530, 1630)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Public Information Officer Lillian Mariano resigned in September.

The Division conducted a two-day Marine Fishing Derby for Kids Only at Dadi Beach on Naval Station on June 22, 1996. A fishing clinic open to the public was also conducted in conjunction with this event.

The Division completed production of a 30-minute video on coral reef ecology intended for use in public fisheries presentations and for distribution to school and public libraries, museums, and other educational institutions. Also completed was a newly revised and expanded coloring book, which has been distributed to all the elementary schools on the island, and a new poster on "Dangerous Sea Creatures" in cooperation with the Guam Coastal Management Program, administered by the Bureau of Planning.

The Division continued to issue press releases on its projects and activities, set up static public displays, conduct press conferences, submit feature articles to the print media, make radio and television appearances, and respond to requests for information from students and members of the general public.

BACKGROUND

The Public Awareness and Conservation Education Program (PACE) was established in support of the Division's mission to protect, preserve, develop and enhance Guam's aquatic and wildlife resources. The program consists of school presentations dealing with aquatic and wildlife conservation, kids' fishing derbies, the production of resource materials for classroom use including coloring books, activity guides, posters and informational flyers, news releases, static public displays, public service announcements, press conferences and feature articles.

Up until FY90, the program was facilitated primarily by a Public Information Officer, and periodically by staff biologists. Since FY90, Conservation Officers have also provided direct support to the PACE effort by conducting classroom visits to address the enforcement aspects of conservation.

The effectiveness of the PACE programs and activities can best be measured by the community's continuing response in reporting suspected poachers and poaching activities to conservation officers and police, the growing interest and demand for resource conservation materials, and the increase in teacher and student requests for fish and wildlife presentations. As in the past, residents continue to report bird sightings, bring in injured birds or birds presumed to be

endangered species, and generally to encourage the institution of more intensive management programs for Guam's fish and wildlife resources.

PROCEDURES AND RESULTS

Activities and efforts during FY96 included the following:

1. Class presentations on endangered species, coral reef ecology and fish and wildlife conservation in general, were delivered public and private elementary schools, middle schools, and high schools, university classes, and groups such as the 4-H Club, Cub Scouts, and Department of Parks and Recreation Summer Camp. Division staff biologists and conservation officers also provided support to the University of Guam's fisheries training program.

2. The Division conducted a 2-day Marine Fishing Derby for Kids Only at Dadi Beach on Naval Station on June 22, 1996. A fishing clinic open to the public was also conducted in conjunction with this event (see F-1R-4, Study 1, Job 2, Appendix 2, Kid's Fishing Derby).

3. Development and production of a new poster entitled "Dangerous Sea Creatures" in cooperation with the Guam Coastal Management Program administered by the Bureau of Planning. The posters have been distributed to all public and private school classrooms and are issued upon request to members of the general public.

4. The Division continues to distribute copies of the expanded sets of flyers, each set consisting of color pictures and accounts on 84 of Guam's marine and terrestrial vertebrates, invertebrates and habitats. The development and production of the flyers were paid by DJ-PR funds; printing was funded by the Bureau of Planning's Coastal Management Program through a grant from the National Oceanic and Atmospheric Administration.

5. The Division distributed color posters on the Mariana fruit bat *(Pteropus mariannus)* to every school and library on Guam. Copies of the poster are available to the public upon request at the Division office. The development and production of the posters were funded by the Wildlife Restoration Program; printing funds came from the Bureau of Planning's Coastal Management Program through a grant from the National Oceanic and Atmospheric Administration.

6. The Division completed production of a 30-minute video on coral reef ecology intended for use in public fisheries presentations and for distribution to school and public libraries, museums, and other educational institutions.

7. Displays on the brown tree snake and various fish and wildlife conservation programs were set up during Earth Week and other similar events.

8. Division programs and activities continue to gain extensive media coverage. Newspaper and television feature articles on Guam rail, Micronesian kingfisher and Mariana crow recovery efforts are periodically done, as are hunting and fishing activities and enforcement. In addition, a number of off-island media visited Guam during the year to film and document brown tree snake impact on Guam's natural resources and efforts to control its spread to other islands.

9. The Division participated in Youth Leadership Day activities.

10. Division staff developed press releases and feature articles and participated in media conferences on various conservation topics.

RECOMMENDATIONS

1. Develop and submit a Grant Proposal for a formal Aquatic Education Program to compliment the existing PACE program.

2. Develop and implement a Hunter Education program to compliment the existing PACE program utilizing Division biologists, conservation officers, and community volunteers as instructors.

3. Develop and implement specific public education programs on the brown tree snake and the recovery programs for the Mariana crow, the Micronesian kingfisher, the Guam rail, and other endangered indigenous species. Attempt to develop feelings of cultural pride and concern for the recovery of indigenous wildlife.

4. Continue to hold freshwater and marine fishing derbies and clinics for children. In addition, develop a new series of freshwater and marine fishing derbies, clinics, and other events for older youths, ages 13 through 17, and for adults.

5. Explore the possibilities of corporate sponsorship for specific endangered species recovery, conservation, and public awareness programs.

6. Continue aquatic and wildlife presentations at public and private schools, libraries, summer camps, after-school programs, and civic organizations.

7. Develop and implement workshops on various natural resource conservation topics for public and private school teachers.

8. Continue public awareness program through press releases, news articles, press conferences and other media to keep the public informed of the progress and accomplishments of the Division's fish, wildlife and endangered species programs.

9. Update existing and develop new public service announcements for television and radio.

10. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, Guam Coastal Management Program, Sea Grant, the University of Guam Extension Service, Department of Parks and Recreation, the Guam Environmental Protection Agency, the U. S. Fish and Wildlife Service, the U. S. National Park Service, and the Guam National Wildlife Refuge.

11. Develop a traveling exhibit program to present information on the Division's fish and wildlife conservation and management programs and natural resource conservation educational materials in village community centers.

PROGRAM COST

The estimated cost of the Division's PACE Program was $75,000.

This report was prepared by: Robert D. Anderson

JOB PROJECT REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-1R-4
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 1

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB 1: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin, Agat Marina, and the Merizo Pier from October 1995 through September 1996. The island-wide offshore catch primarily from small recreational-type vessels is estimated to be 501.7 metric tons (m.t.) for that period (Table 1). The bulk of the catch, 363.3 m.t., was landed by trolling method during an estimated 66,638 boat-hours of effort. The bulk of the troll catch, 352.0 m.t., consisted of five pelagic species. Bottomfishing produced an estimated 66.6 m.t., primarily snappers and emperors, and night-light jigging for atulai produced an estimated 9.8 m.t. Spearfishing produced 61.6 m.t. of finfishes and shellfish. Approximately 2.4 m.t. of finfish were caught by infrequently encountered methods such as gillnet, castnet, jigging, and casting. Catches by these methods may be under-estimated. Deficiencies in the current survey design and analysis have been identified, and should be rectified with the implementation of a new survey design and new computerized database during FY97.

TABLE 1: Total offshore catch by method for FY96.

Offshore Fisheries Method	FY96 Catch (metric tons)
Trolling	363.6
Bottomfishing	66.6
Spearfishing	59.3
Atulai night-light	9.8
Other Methods	2.4
TOTAL FY96 OFFSHORE CATCH	501.7

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used, and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past 19 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. During the 1980s, major advances have been made in both field survey techniques and in the area of

computerized statistical analysis. The combined efforts of DAWR and the National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3) made it possible to employ computerized statistical analysis for the period FY77-91. However, statistics could not be computed since FY92 due to the lack of adequate computer hardware and software.

OBJECTIVES

1. To quantify fishing participation, effort, and catch which occurs outside the reef margin in boats.

2. To collect biological data from the specimens examined during interviews.

PROCEDURES

During FY96, interview of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin (two weekends and two weekdays), two days each month at the Agat Marina (one weekend and one weekday), and two days each month at the Merizo Pier (one weekend and one weekday). Each of these days were randomly selected weekdays (WD) and weekend days (WE/H). Agana Boat Basin surveys consisted of two periods, one from 0500 to 1200 hours and from 1600 to 2400. Agat Marina and Merizo Pier survey times differed slightly in the morning survey hours, 0530 to 1200 and 0600 to 1100 hours respectively. Island-wide participation was determined by means of a morning and evening survey, one weekday and one weekend a month, of all public boat launching areas in which all trailers attached to vehicles were counted, but no interviews were taken. This assumes that the percentage of boats operating out of the Agana Boat Basin, Agat Marina, and the Merizo Pier combined engaging in fishing, and the proportion of those fishing boats engaging in each offshore method is representative of the island as a whole.

Sampling and analytical procedures used remain unchanged from FY92, with preliminary estimates without statistical analysis determined through the use of a computerized spreadsheet. The following steps were taken to obtain monthly estimates of total participation, effort, and catch for all methods.

1. Participation, effort, catch, and total number and weight of all species for each method encountered and interviewed were input into a computerized spreadsheet using Microsoft Excel, version 5.0.

2. Catch totals for each method were divided by P_1 (% confidence of level of coverage at surveyed site) and P_2 (% of total island-wide effort at surveyed site) ratios to obtain an island-wide estimate. All methods were divided by a yearly average P_2 value. The method for determining P_1 and P_2 values is outlined in the FY85 annual report.

3. The average of each daily parameter for each type day (WD or WE/H) was multiplied by the number of weekend and weekdays in the month to obtain WD and WE/H monthly estimates. WD and WE/H totals were summed to obtain monthly totals.

4. For trolling, estimates for the month of August are based on a 28-day expansion for trolling, with catch, effort, and participation during the Guam-Marianas International Fishing Derby (GMIFD) added for trolling. (Appendix 1). Other one- and two-day derbies with relatively low turnouts or which were strictly tag and release were not considered separately from the normal expansion.

RESULTS

Trolling

Including the results of the Guam-Marianas International Fishing Derby, approximately 363.6 m.t. of troll-caught fish were landed islandwide during FY96 (Table 2).

TABLE 2: Estimated monthly and annual trolling participation, effort, and catch during FY96. Weights are in kilograms (1 kg = 2.2 lbs.)

A.) PARTICIPATION

MONTH	NO. OF PERSONS	NO. OF BOAT TRIPS
OCT	4,832	1,045
NOV	7,556	1,697
DEC	5,955	1,326
JAN	6,224	1,458
FEB	6,465	1,550
MAR	6,098	1,551
APR	5,981	1,559
MAY	5.853	1,380
JUN	7,677	1,711
JUL	7,119	1,502
AUG	4,906	1,178
SEP	3,759	829
TOTAL	72,425	16,786

B.) EFFORT

MONTH	NO. OF PERSONS-HRS	NO. OF BOAT-HOURS
OCT	17,378	4,241
NOV	25,203	6,048
DEC	18,959	4,280
JAN	21,004	5,934
FEB	23,220	6,126
MAR	22,060	6,022
APR	22,924	6,517
MAY	21,045	5,246
JUN	33,149	7,899
JUL	26,567	5,805
AUG	19,877	5,208
SEP	14,061	3,312
TOTAL	265,446	66,638

C.) CATCH

MONTH	NO. OF KILOGRAMS	KG/B-T	KG/B-H	KG/G-H
OCT	29,399	28.1	6.9	1.5
NOV	13,363	7.9	2.2	0.7
DEC	9,479	7.1	2.2	1.0
JAN	42,730	29.3	7.2	2.0
FEB	56,365	36.4	9.2	2.2
MAR	32,198	20.8	5.3	1.5
APR	26,648	17.1	4.1	1.1
MAY	26,409	19.1	5.0	1.0
JUN	36,237	21.2	4.6	1.1
JUL	31,251	20.8	5.4	1.4
AUG	37,753	32.0	7.2	1.5
SEP	21,776	26.3	6.6	1.6
TOTAL	363,608	22.2	5.5	1.4

Monthly catches ranged from a high of 56.4 m.t. in February to a low of 9.5 m.t. in December. An estimated 66,638 boat-hours were spent trolling, with a yearly average catch rate of 5.50 kg/boat-hour or 1.4 kg/gear-hour. Monthly catch rates, as catch per unit of effort (CPUE), ranged from 2.2 kg/gear-hour in February to 0.7 kg/gear-hour in November.

The five major pelagic species accounted for 96.8% of the total troll catch (Table 3). Mahimahi (*Coryphaena hippurus*; 34.6% of the troll catch) was the most commonly caught, followed by bonita (*Katsuwonas pelamis*; 26.7%), wahoo (*Acanthocybium solandri*; 12.2%), Pacific blue marlin (*Makaira mazara*; 11.7%), and yellowfin tuna (*Thunnus albacares*; 11.6%). Scombroids collectively comprised 50.6% of the total trolling catch.

Overall estimated troll catch increased slightly from FY94, increasing 8%. Estimated landings increased for mahi, yellowfin tuna, and bonita compared with FY94. Yellowfin experienced the largest increase of all pelagic species, 28.9 m.t. to 42.1 m.t., an increase of 46%. Mahimahi catch increased from 90.4 m.t. to 125.9 m.t., an increase of 39%, while bonita increased slightly, 93.7 m.t. to 97.0 m.t., an increase of 4%. Yearly catch decreased for wahoo (47.6 m.t. to 44.4 m.t., decreasing 7%) and blue marlin (66.4 m.t. to 42.7 m.t., a decrease of 36%). Other species caught trolling increased 18%, 9.8 m.t. to 11.5 m.t. These include barracuda, rainbow runner, kawakawa, shortbill spearfish, trevally, requiem sharks, uku, and other rarely caught fish.

Compared with FY94, participation in the fishery increased with the number of persons participating increased 11%. The catch rate increased slightly, up 5.50 kg/boat-hour from 5.2 kg/boat-hour. The highest monthly catch rate was observed in February, with 9.20 kg/boat-hour. Comparing effort, person-hours increased slightly (2%) while the number of boat-hours decreased slightly (5%).

TABLE 3: Monthly and annual composition of the Guam trolling catch during FY96. Estimated weights are in kilograms and include the GMIFD.

Family and Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TOTAL
Balistidae													
Canthidermis maculatus					58.4								58.4
Belonidae													
Strongylura incisa				6.6									6.6
Tylusurus specie		18.7							118.2				136.9
Carangidae													
Caranx ignobolis					102.2								102.2
Caranx melampygus	59.84			43.4									103.2
Elagatis bipinnulatus	41.31	24.8		231.6	179.6	29.2	891.2	292.7	112.4	4,211.2	389.9	136.5	4,740.4
Carcharhinidae													
Carcharhinus longimanus				875.8									875.8
Carcharhinus galapagensis											656.8		656.8
Coryphaenidae													
Coryphaena hippurus	1,644.5	2,566.5	5,822.4	29,638.5	47,011.1	24,951.3	8,050.3	3,125.4	556.1	500.8	279.5	1,722.0	125,868.4
Lutjanidae													
Aphareus furca						4.1	8.2		43.8		8.8		64.8
Aprion virescens										24.8	18.6		43.4
Scombridae													
Acanthocybium solandri	5,791.6	5,256.7	2,633.8	6,415.9	3,313.3	4,332.8	3,785.4	659.7	967.6	1,718.2	5,020.5	4,517.9	44,413.4
Euthynnus affinis	33.8		94.9		396.3	45.4	190.0	42.5	21.2	363.3	302.6	100.3	1,589.3
Grammatorcynos bilineatus					14.6								14.6
Gymnosarda unicolor	126.5						99.3	5.8	36.2	158.2	119.7		545.5
Katsuwonus pelamis	6,076.8	4,249.7	567.1	2,687.1	2,135.8	1,418.0	9,201.5	13,216.4	13,924.4	19,089.5	14,753.0	9,656.0	96,975.4
Thunnus albacares	5,467.6	1,056.7	218.9	1,629.6	1,895.3	828.6	3,746.0	7,177.5	7,651.6	5,015.3	5,010.6	2,387.9	42,085.6
Sphyraenidae													
Sphyraena barracuda	59.6	172.2	142.3	218.9		58.4	150.3	87.6	170.3	113.3	691.0	110.9	1,974.8
Sphyraena genie		17.5											17.5
Istiophoridae													
Makaira mazara	10,098			982.3	1,258.2	530.1	525.5	1,590.2	12,635.6	1,856.6	10,501.8	2,736.7	42,715.5
Tetrapturus angustirostris								211.6				408.0	619.6

Bottomfishing

An estimated 66.6 m.t. of bottomfishes were landed island-wide during FY96 (Table 4). Estimated monthly catches ranged from a high of 11.1 m.t. in August to a low of 1.1 m.t. in February. Bottomfish landings fluctuated widely, with generally poorer catches from November to February. An estimated 7,126 boat trips were spent during 46,965 boat-hours of bottomfishing. Monthly catch rates ranged from 0.3 kg/gear-hour in November and January to 1.2 kg/gear-hour in July.

TABLE 4: Estimated monthly and annual bottomfish participation, effort, and catch during FY96. Weights are in kilograms (1 kg = 2.2 lbs.)

A.) PARTICIPATION

MONTH	NO. OF PERSONS	NO. OF BOAT TRIPS
OCT	1,037	455
NOV	1,830	726
DEC	2,284	689
JAN	1,035	376
FEB	816	253
MAR	1,387	575
APR	1,626	596
MAY	1,676	670
JUN	1,849	757
JUL	1,404	597
AUG	2,464	878
SEP	1,700	553
TOTAL	19,108	7,126

B.) EFFORT

MONTH	NO. OF PERSONS-HRS	NO. OF BOAT-HOURS
OCT	5,362.0	2,440.7
NOV	8,163.8	3,086.8
DEC	9,221.7	2,822.5
JAN	5,174.3	1,975.7
FEB	2,744.0	914.7
MAR	6,595.6	2,824.3
APR	6,610.8	2,736.4
MAY	7,611.8	2,905.4
JUN	8,350.4	3,432.6
JUL	5,598.5	2,307.9
AUG	12,613.2	4,293.9
SEP	8,863.4	3,103.2
TOTAL	86,909.4	32,843.7

C.) CATCH

MONTH	NO. OF KILOGRAMS	KG/B-T	KG/B-H	KG/G-H
OCT	4,402.6	9.7	1.8	0.7
NOV	2,521.2	3.5	0.9	0.3
DEC	3,559.8	5.2	1.3	0.5
JAN	2,377.2	6.3	1.3	0.3
FEB	1,059.2	4.2	1.4	0.5
MAR	4,348.3	7.6	1.6	0.7
APR	7,590.6	12.7	2.8	1.1
MAY	7,564.8	11.3	2.7	0.9
JUN	6,815.8	9.0	2.0	0.8
JUL	7,009.2	11.7	3.1	1.2
AUG	11,055.7	12.6	2.6	0.9
SEP	8,275.9	15.0	3.0	0.9
TOTAL	66,580.2	9.6	2.1	0.8

The estimated bottomfishing catch for FY96 increased approximately 53% compared with FY94. This may be due primarily to the significant increase in participation and effort. The number of persons participating in the fishery increased almost 200%, 19,108 persons compared with 9,694 in FY94. Effort also increased approximately 220%. However, overall catch rate decreased, with kg/boat-hour decreasing 28%, 2.1 kg/boat-hour down from 2.9 kg/boat-hour, and kg/person-hour decreasing 28%, 0.79 kg/person-hour down from 1.1 kg/person-hour. The catch per gear hour for FY96 had a yearly average of 0.78, ranging from 0.3 in November and January to 1.2 kg/gear-hour in July.

The composition of FY96 bottomfish catch was also very similar to that of recent years, with emperors *(Lethrinidae*) and snappers *(Lutjanidae*) accounting for 22% and 29% of the weight landed, respectively (Table 5). The emperor catch was dominated by the redgilled emperor (*L. rubrioperculatus*, 3.7 m.t.) while the snapper catch was dominated by the yellowtail kalikali (*Pristipomoides auricilla*, 4.6 m.t). Jacks and trevallys *(Carangidae*, 8.1 m.t.) ranked third in importance, followed by groupers (*Serranidae*; 5.2 m.t.) with the black-tipped grouper (*Epinephelus fasciatus*; 3.3 m.t.) dominating. Other important bottomfish families include *Scombridae* (2.8 m.t., 4.2%), *Mullidae* (1.2 m.t., 2.5%), and *Holocentridae* (1.9 m.t., 2.8%).

Relatively shallow water species (found primarily at depths of 150 meters or less) comprised approximately 76% of the catch compared with deeper water species (primarily *Etelinae).* The continued importance of small species with high turnover rates at shallow to moderate depths (e.g. *L. rubrioperculatus* and *E. fasciatus*) is indicative of a heavily-fished resources. Catch rates have decreased at least 27% in kg/boat-hour and kg/person-hour from FY94. Unchecked increases in participation and effort could result in further lowering CPUEs and catches in the future.

TABLE 5: Monthly composition of the Guam bottomfish catch during FY96 by Family and most common species. Estimated weights are in kilograms.

FAMILY	TOTAL CATCH	% OF TOTAL CATCH
Lutjanidae	19,065	28.6
(Etelinae) A.virescens	2,837	(14.8)+
P.auricilla	4,568	(24.0)+
P.filamentosus	1,098	(5.8)+
P.flavipinnis	1,308	(6.9)+
P.zonatus	2,372	(12.4)+
E.coruscans	973	(5.1)+
E.carbunculus	772	(4.1)+
(Lutjaninae) L. bohar	807	(4.2)+
L. monostigmus	824	(4.3)+
L.fulvus	221	(1.2)+
L.kasmira	860	(4.5)+
L.argentimaculatus	215	(1.1)+
L.gibbus	256	(1.3)+
Lethrinidae	13,184.8	21.6
L.harak	1,919	(14.6)+
L.obsoletus	2,753	(20.9)+
L.xanthochilus	3,031	(23.0)+
L.rubrioperculatus	3,775	(28.6)+
Serranidae	5,.908	9.7
E. fasciatus	3,775	(63.9)+
C. urodeta	485	(8.2)+
V.louti	481	(8.1)+
Holocentridae	1,871.1	2.5
S.tiere	888	(47.5)+
Mullidae	1,171.2	1.8
Carangidae	9,528.8	15.6
S.crumenophthalmus	1,744	(18.3)+
C.sexfasciatus	820	(8.6)+
C.orthogrammus	1,970	(20.7)+
C.melampygus	2,000	(21.0)+
C.lugubris	1,168	(12.3)+
Balistidae	460.2	**
Labridae	391.9	**
Priacanthidae	136.5	**
Acanthuridae	249.1	**
Sphyraenidae	472.9	**
Mugilidae	*	**
Scombridae	2,810.5	3.7
Fistulariidae	*	**
Apogonidae	*	**
Pempheridídae	*	**
Malacanthidae	*	**
Nemipteridae	*	**
Congridae	*	**
Hemigalaeidae	149.9	**

Carcharhinidae	99.9	**
Gempylidae	542.8	**
Synodontidae	*	**
Belonidae	97.9	**
Scaridae	64.9	**
Monacanthidae	*	**
Muraenidae	*	**
Other & Misc. Bottomfish***	10,236.1	16.7
TOTAL	66,580.0	100.0

*Estimated catch less than 50 kg. **Estimated % total less than 1%. ***Other by-catch or unable to survey catch. +% of specie in Family.

Spearfishing

An estimated record 59.3 m.t. of speared fish, crustaceans, and mollusks were landed during FY96 (see Table 6). This is a 210% increase from FY94. This significant increase could be due primarily to an increase in participation and effort. Compared with FY94, the number of persons participating in spearfishing increased 194%, person-hours increased 290%, and boat-hours increased 272%. However, the average catch rate decreased from FY94, with kg/boat-hour decreasing 23%, 8.2 kg/boat-hour down from 10.6 kg/boat-hour, and kg/person-hour decreasing 29%, 2.4 kg/person-hour down from 3.4 kg/person-hour. The yearly catch rate for FY96 was 2.9 kg/gear-hour. The catch rate for scuba spearfishing decreased 48% from FY94 to 3.71 kg/person-hour, down from 7.1 kg/person-hour. Snorkel spearfishing also decreased 11%, 1.42 kg/person-hour down from 1.6 kg/person-hour. The average kg/boat trip for FY96 was 22.1 kg. There appears to be a continuing trend of decreasing catch rates for spearfishing. Although no confidence limits could be placed on estimates since FY90, this trend could be an indication of overharvesting of the shallowest and most accessible resource and is a cause for concern. During FY96, an increase in effort by "teams" of scuba spearfishing groups was observed to fish as many as three times a week. One of these boats surveyed during FY96 had an average catch of over 100 kg. per trip. For the major finfish family groups caught by spearfishing, scuba spearfishing accounted for over 70% of the take.

TABLE 6: Estimated monthly and annual spearfish participation, effort, and catch during FY96. Weights are in kilograms (1 kg = 2.2 lbs.)

A.) PARTICIPATION

MONTH	NO. OF PERSONS	NO. OF BOAT TRIPS
OCT	156	63
NOV	285	119
DEC	1,099	260
JAN	414	158
FEB	593	158
MAR	1,426	362
APR	1,239	421
MAY	707	214
JUN	880	268
JUL	746	249

AUG	524	159
SEP	730	261
TOTAL	8,800	2,691

B.) EFFORT

MONTH	NO. OF PERSONS-HRS	NO. OF BOAT-HOURS
OCT	593.8	250.0
NOV	729.5	302.5
DEC	2,370.7	556.5
JAN	1,344.9	514.9
FEB	1,030.0	268.9
MAR	4,239.4	990.5
APR	3,478.4	1,116.6
MAY	2,250.0	696.4
JUN	3,099.5	784.4
JUL	1,596.0	559.6
AUG	1,685.5	489.7
SEP	2,086.7	691.2
TOTAL	24,504.5	7,221.4

C.) CATCH

MONTH	NO. OF KILOGRAMS	KG/B-T	KG/B-H	KG/P-H	KG/G-H
OCT	760.3	12.2	3.0	1.3	1.5
NOV	1,927.4	16.2	6.4	2.6	2.6
DEC	9,089.5	34.9	16.3	3.8	5.1
JAN	2,404.4	15.3	4.7	1.8	1.9
FEB	805.1	5.1	3.0	0.8	0.9
MAR	9,890.9	27.3	10.0	2.3	2.7
APR	12,649.8	30.1	11.3	3.6	4.7
MAY	4,854.4	22.7	7.0	2,2	2.6
JUN	6,715.2	25.1	8.6	2.2	2.5
JUL	3,240.1	13.0	5.8	2.0	2.5
AUG	2,330.8	14.6	4.8	1.4	1.9
SEP	4,670.1	17.9	6.8	2.2	2.8
TOTAL	59,337.9	22.1	8.2	2.4	2.9

As in previous years, surgeonfishes (*Acanthuridae*; 31%) and parrotfishes (*Scaridae*; 24%) dominated the FY96 spearfishing finfish catch (Table 7). Next in order of importance were the groupers (*Serranidae*; 3%), emperors (*Lethrinidae*; 3%), rabbitfishes (*Siganidae*; 2%), goatfishes (*Mullidae*; 2%), rudderfishes (*Kyphosidae*; 2%), and squirrelfishes (*Holocentridae*; 2%). The non-fin fish catch was dominated by *Trochus niloticus*, 3.6 m.t., spiny lobster (*Panulirus penicillatus*, 2.2 m.t.), and octopus, 0.6 m.t. (Readers

should also refer to study F-1, Job 2 for estimates of spearfishing from shore to gain a more complete picture of FY96 spearfishing activity on Guam.)

TABLE 7: Composition of the Guam spearfish catch during FY96 by Family and most common species. Estimated weights are in kilograms.

FAMILY	Total Catch	% Total Catch	% Scuba Catch
Acanthuridae	18,151	31	77
A.lineatus	789		
N.lituratus	3,320		
N.unicornis	11,421		
Scaridae	14,476	24	71
H.longiceps	4,623		
S.microrhinos	1,475		
S.altipinnis	1,515		
Lethrinidae	1,756	3	86
M.grandoculus	716		
Lutjanidae	678	1	21
Kyphosidae	1,014	2	25
K.cinerascens	744		
Siganidae	1,356	2	62
S.punctatus	547		
S.argenteus	511		
Serranidae	1,989	3	78
C.argus	379		
P.laevis	332		
V.louti	326		
Holocentridae	969	2	86
M.berndti	548		
Mullidae	1,117	2	75
P.barberinus	570		
Carangidae	643	1	72
C.melampygus	559		
Labridae	412	**	19
Priacanthidae	*	**	51
Balistidae	409	1	79
Haemulidae	262	**	88
Scombridae	141	**	100
Dasyatididae	302	**	100
Cirrhitidae	*	**	0
Chaetodontidae	*	**	0
Monacanthidae	56	**	29
Caesionidae	*	**	0
Muraenidae	*	**	0
Pomacanthidae	*	**	0
Diodontidae	*	**	0
Synodontidae	*	**	0
Nemipteridae	*	**	0
Belonidae	*	**	0
Tetraodontidae	*	**	100
Apogonidae	*	**	100
Fistulariidae	*	**	100

Bothidae	*	**	0
Misc. Fish***	8,672	15	69
Trochus niloticus	3,471	6	35
Bivalves	66	**	0
Octopus sp.	625	1	16
Spiny lobster	2,166	4	57
Slipper lobster	*	**	100
Misc. crabs	175	**	8
Squid	*	**	0
Triaenodon obesus	138	**	100
Total Spearfish Catch	**59,338**		

*Estimated catch less than 50 kg. **Estimated % total less than 1%. ***Other by-catch or unable to survey catch. +% of species in Family.

Atulai Night-Light Jigging

Atulai night-light fishing was encountered year round during FY96. An estimated 12.1 m.t. of fish were landed during 7,026 boat-hours of effort (Table 8). Most of this consisted of atulai (*Selar crumenophthalmus* ; 11.2 m.t., 92%). The remaining incidental catch consisted of jacks (*Carangidae*; 0.4 m.t., 4%), snappers (*Lutjanidae*; 0.2 m.t., 2%), barracudas (*Sphyraenidae*; 0.04 m.t., 2%), and negligible quantities of squirrelfishes (*Holocentridae*, 0.1%).

TABLE 8: Estimated annual atulai night-light participation, effort, and catch during FY96. Weights are in kilograms (1 kg = 2.2 lbs).

A. PARTICIPATION	No. of Persons	1,655
	No. of Trips	732
B. EFFORT	No. of boat hours	5,689
	No. of person hours	13,216
C. CATCH	No. of Kg	9,863
	Kg/boat-hour	1.73
	Kg/person-hour	0.75
	Kg/gear-hour	0.61

DISCUSSION

The overall offshore catch for FY96 was estimated to be 21% higher than FY94. The data shows a slight catch increase with trolling (8%), and significant catch increases with bottomfishing (53%), spearfishing (210%), and atulai night light jigging (337%). However, the increase in offshore catch may not be an accurate reflection of the average fishing event and islandwide offshore fishing activity, and may be an overestimation of some methods. This may be due to deficiencies in the present expansion methodology, changes in the fishery, and survey interviews, which may be skewed towards charter boats and highliners.

Island-wide offshore activity for a specific method was estimated by determining the activity of that method at the three sampled ports and adjusting by P_2. This may have

overestimated offshore catch. Also, the activity of trailered vehicles at the three sampled ports may not be representative of the activity of trailered vehicles elsewhere around the island. Trailered vehicles at the three sampled ports are dominated by trolling and bottomfishing, while trailered vehicles at other areas may have a higher proportion of other activities such as commercial and recreational jetskiing and inshore netting, and a different proportion of bottomfishing, trolling, and spearfishing activities. This becomes significant during summer lull months when the number of trailered vehicles increases on the east-side of the island, dominated primarily by bottomfishing and spearfishing. A lower proportion of trailered vehicles at the three sampled sites lowers P_2, and if the activity of trailered vehicles at the three sampled sites has a higher proportion of offshore methods, offshore catch may be overestimated.

The total offshore catch is determined by the catch rate of surveyed returning boats expanded by island-wide participation. However, a higher proportion of interviews used to determine participation and the catch rate for trolling and spearfishing is obtained from charter troll trips and highliner scuba spear teams respectively. This may have overestimated the offshore catch for these methods since CPUE, total catch, and participation for charter trips and scuba spearfishing highliners are generally higher.

RECOMMENDATIONS

It is recommended that a new survey design and new computerized database be implemented, possibly with the assistance of NMFS for FY97. Computerized statistical analysis should begin to address some of the above concerns and should include calculating accurate confidence limits, analyzing the charter fishery separately, and analyzing shallow and deepwater bottomfishing complexes separately. The new survey design should also utilize additional location codes to distinguish between trolling and bottomfish trips that occur in Guam's territorial waters versus federal waters.

It is also recommended that participation in future GMIFD events be discontinued to better utilize fisheries staff. Participation should be limited to enhancing the boat ramp facilities and providing limited technical assistance, as requested.

PROGRAM COSTS

The estimated cost of the Offshore Fisheries Survey Project was $115,000.

Report prepared by Thomas Flores, Jr.

APPENDIX 1

Guam-Marianas International Fishing Derby

PERIOD COVERED: August 9-11, 1996

INTRODUCTION

The first annual Guam-Marianas International Fishing Derby (GMIFD), formerly the Guam International Fishing Derby (GIFD), sponsored by the Guam Fishermen's Cooperative Association, was held August 9-11, 1996. Awards were given to the boat entrant (captain/anglers) who landed the top six heaviest marlin (*Makaira mazara),* yellowfin tuna (*Thunnus albacares*), wahoo (*Acanthocybium solandri),* mahimahi *(Coryphaena hippurus*), and bonita (*Katsuwonus pelamis).* The marlin category also included other billfish such as sailfish (*Istiophorus platypterus)*, broadbill swordfish (*Xiphias gladius)*, and shortbill spearfish *(Tetrapturus angustirostris*). Entrants could place in multiple categories but only once in a category.

PROCEDURES

DAWR staff were present at the derby stations at the Agana Boat Basin, Agat Marina, and the Merizo Pier during the derby check-in and check-out times: 0600 to 1900 on August 9 and 10, and 0600 to 1700 on August 11. A log of all departing and returning boats was kept and as many returning boats as possible were intercepted and interviewed.

Parameters of participation and effort were determined by using daily averages in place of missing data wherever possible. This was done for number of fishermen, number of lines used, and "down time" when determining hours spent fishing. The number of boat trips was obtained directly from the boat log.

Determination of catches required a subjective appraisal of what species were likely to be present in non-intercepted boats. Average daily catch rates by species were assigned to non-intercepted boats in order to determine daily totals. An average of 77.1% of boats participating in the three day event were intercepted and interviewed (80.4%, 82.8%, and 68.1% of boats participating on August 9, 10, and 11th respectively). Boats were not intercepted if they chose to continue fishing past the official derby time or if boats arrived simultaneously in large numbers and could not all be interviewed.

RESULTS

Participation

One hundred and four boats made a total of 284 fishing trips during the course of the derby (Table 1). Final averages included: 3.0 anglers pulling 4.2 lines per fishing trip and 8.2 hours per fishing trip.

Table 1: Daily participation, effort and catch in the first annual Guam-Marianas International Fishing Derby. Weights are expressed in kilograms.

	Day 1 AUG 9	Day 2 AUG 10	Day 3 AUG 11	DERBY TOTALS
Number of boats	92	93	92	104
Number of boat trips	93	97	94	284
Number of fishermen	274	294	295	863
Average number of men per boat	2.95	3.03	3.09	3.0
Number of lines used†	391	413	399	1203
Average number of lines per boat	4.21	4.26	4.18	4.2
Fished Hours	799.9	789.8	741.7	2,331.3
Average time spent fishing	8.60	8.14	7.77	8.19
Fisherman hours	2,320.2	2,313.4	2,259.5	6,893.1
Line hours	3,401.5	3,401.2	3,144.4	9,947.0
Number of fish landed	406	496	546	1,448
Catch landed††	2,059.2	3,122.3	2,462.3	7,643.9
kg./boat	22.43	33.93	26.61	27.66
kg./boat trip	22.14	32.19	25.79	26.78
kg./boat hour fished	2.57	3.95	3.32	3.27
kg./person hour	0.89	1.35	1.09	1.11
kg./line hour	0.61	0.92	0.78	0.77

†Artificial data based on the average number of lines per boat interviewed multiplied by the number of boats.

††Includes incidental catch of trolling non-derby species. Bottomfish catch not included.

Catch

A total of 7,643.9 kg. of trolling species was landed (Table 2). The bulk of the catch (97%) consisted of four species: yellowfin tuna (18%, 1,381.0 kg.), bonita (25%, 1,878.0 kg.), blue marlin (26%, 1,995.8 kg.), and wahoo (28%, 2,129.9 kg.). The remainder of the troll catch consisted of barracuda (2%, 148.0 kg.) and approximately one percent combined of dogtooth tuna *(Gymnosarda unicolor)*, mahimahi, rainbow runner *(Elagatis bipinnulatus)*, kawakawa (*Euthynnus affinis)*, jobfish or uku *(Aprion virescens)*, and crocodile needlefish *(Tylosurus crocodilis)*. In addition to trolling, approximately 305.9 kg. of bottomfish were caught by derby entrants.

Fishing Areas

Useable locality data was obtained from 77% of the fishing trips. This made it possible to compare catches and catch rates by Area (Table 3). Slightly more boats fished north of the Agana Boat Basin (52%). Approximately half of these boats fished the northern banks (Rota Banks and Pati). Of the 48% that fished south of Agana Boat Basin, 83% (or 40% of the total) fished the southern banks (11 mile, Galvez, Santa Rosa, Baby, and White Tuna).

Of the 220 boat trips intercepted and interviewed, the number of marlin intercepted were approximately the same for North and South regions, and the northern and southern banks. Approximately 76% of the yellowfin intercepted were caught in the South region with the southern banks accounting for 86% of the South yellowfin total and 66% of all the yellowfin intercepted. This trend was also true for wahoo, with 85% caught in the South

Table 2: Daily troll catch composition of the first annual Guam-Marianas International Fishing Derby. Weights are expressed in kilograms.*

	Day 1 Aug 9			Day 2 Aug 10			Day 3 Aug 11			TOTALS		
SPECIES	Number Caught	Total Wt.	Ave Wt.	Number Caught	Total Wt.	Ave Wt.	Number Caught	Total Wt.	Ave Wt.	Number Caught	Total Wt.	Ave Wt.
Derby												
Blue Marlin	9	817.5	90.8	7	688.9	98.4	6	489.4	81.6	22	1,995.8	90.7
Yellowfin	106	505.4	4.8	140	513.6	3.7	72	362.0	5.0	318	1,381.0	4.3
Bonita	233	742.1	3.2	163	325.7	2.0	376	810.3	2.2	772	1,878.0	2.4
Wahoo	113	950.8	8.4	59	451.8	7.7	50	727.3	14.5	222	2,129.9	9.6
Mahimahi	2	16.81	8.4	5	8.1	1.6	0	0	0	7	24.9	3.6
Non-Derby												
Barracuda	21	63.9	3.0	10	33.8	3.4	13	50.4	3.9	44	148.0	3.4
Rainbow runner	6	20.7	3.5	7	10.5	1.5	22	51.2	2.3	35	51.3	1.5
Kawakawa	1	0.1	0.1	5	2.5	0.5	6	2.7	0.5	12	5.3	0.4
Jobfish	0	0	0	6	18.6	3.1	0	0	0	6	18.6	3.1
Needlefish	0	0	0	0	0	0	1	0.23	0.23	1	0.23	0.23

*Figures for non-derby species are based on an expansion that accounts for returning vessels that were missed. Expanded numbers of fishes are rounded to the nearest whole number. In cases in which a single fish of a species was caught, the expanded weight may exceed the average weight of that fish.

Table 3. Effort, catch, and troll catch rates by area for the participants of the first annual Guam-Marianas International Fishing Derby. Numbers based on the 220 boat trips that were intercepted by DAWR[1]

Area	Effort (number of boat trips)	Catch: Blue marlin no.	Blue marlin kg.	Yellowfin tuna no.	Yellowfin tuna kg.	Wahoo no.	Wahoo kg.	Mahimahi no.	Mahimahi kg.	Catch Rate (no. and kg./trip): Blue marlin no.	Blue marlin kg.	Yellowfin tuna no.	Yellowfin tuna kg.	Wahoo no.	Wahoo kg.	Mahimahi no.	Mahimahi kg.
North Total	117	9	884.8	59	218.3	26	219.6	4	6.7	0.08	7.6	0.5	1.9	0.2	1.9	0.03	0.2
Northern Guam[2]	47	4	399.6	12	33.4	9	90.2	-	-	0.09	8.5	0.3	0.7	0.2	1.9	-	-
Northern Banks	70	5	485.2	47	184.9	17	129.4	4	6.7	0.07	6.9	0.7	2.6	0.2	1.9	0.03	0.1
South Total	103	8	676.3	191	859.9	148	1,414.2	2	13.5	0.08	6.6	1.9	8.4	1.4	13.7	0.02	0.1
Southern Guam[3]	15	3	225.4	26	174.1	19	205.3	-	-	0.2	15.0	1.7	11.6	1.3	13.7	-	-
Southern Banks	88	5	450.7	165	685.8	129	1,209.0	2	13.5	0.06	5.1	1.9	7.8	1.5	13.7	0.02	0.2
Total	220	17	1,61.1	250	1,078.2	174	1,633.8	6	20.2	0.2	13.3	1.1	4.9	0.8	7.4	0.03	0.1

[1]77% of the total derby trips (See "Procedures" section)

[2]North of Orote Pt. to Pati Pt.

[3]South of Orote Pt. to Inarajan.

region. Approximately 87% of the wahoo caught in the South region were caught at the southern banks, which accounted for 74% of all the wahoo intercepted. Only six mahimahi were intercepted during the derby, caught at either the northern or southern banks.

ACKNOWLEDGMENTS

The fisheries staff of the Division of Aquatic and Wildlife Resources wish to thank DAWR staff from the Technical Assistance Program and the Law Enforcement section, the competing anglers, the Guam Fishermen's Cooperative Association, and members of the First Annual Guam-Marianas International Fishing Derby Committee for their cooperation and assistance in providing the information that made this report possible. This cooperation made obtaining the information easier, insuring a more accurate collection of data and better information for the fishermen.

Report prepared by Thomas Flores, Jr.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-4
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1995 to September, 1996. The total estimated inshore fisheries catch for this time period was 30.0 mt (metric tons), 94% of which were finfish (excluding juvenile rabbitfish or mañåhak). Hook and line was the most practiced method accounting for 70% of the total participation (excluding seasonal fisheries data) or 42,152 participants. In terms of catch rate, gill netting was the most successful of all the daytime methods, yielding approximately 1.44 kg/gear-hour (gh) with a daytime harvest of 5.8 mt, and scuba spear was the most successful nighttime fishing method, yielding approximately 3.85 kg/gh with a nighttime harvest of 0.6 mt. Hook and line was the most successful method in terms of the overall harvest, yielding approximately 0.26 kg/gh with a total harvest of 14.4 mt. The seasonal mañåhak catch was approximately 4.3 mt (9.16 kg/gh) in FY96.

Aerial Survey

The aerial survey report is included in Appendix 1.

Kid's Fishing Derby

The Kid's Fishing Derby report is included in Appendix 2.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatics and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational/ subsistence fishing activities have come to be based on more reliable data analysis techniques.

OBJECTIVES

1. To establish baseline catch and effort data for reef fish species necessary to develop a fisheries management plan for Guam.

2. To gather limited biological data on Guam's fisheries for management purposes.

PROCEDURES

During FY96, four "inshore-catch" survey days were selected per month. Fishermen-intercept interviews were conducted to determine amount of effort, fishing method, location, reef zone, species composition, and amount caught for both day and night fishing. The day survey covered a six-hour interval (beginning at 0630h) and the night survey covered a five-hour interval (beginning at dusk or 1900h). Only one of three survey regions (Figure 1) was selected for each "inshore-catch" day and fisheries data collection was restricted to that region. However, because of infrequently interviewed methods, e.g., drag netting, representative samples were sometimes difficult to obtain. Therefore, if a particular fishing method was not observed within the selected survey area during the survey, one or both of the other two areas could be surveyed for those methods.

During FY96, day and night "inshore-participation" surveys were conducted on four randomly selected days per month, which did not occur on the same days as the "inshore-catch" surveys. These surveys entailed making visual observations of fishing participation within readily accessible portions of Guam's coastline (Fig. 1, locations: 1-71). Fishing effort data is collected by instantaneous counts (while driving in a continuous route) around the island. The route is alternated each survey between "clockwise" and "counterclockwise" and the starting locations are randomly selected (Fig. 2). Since the participation survey includes both day and night fishing, start times begin at 0630h and 1900h and end once the entire island circuit has been completed.

Because the coastal fishing participation continues to expand into more remote areas, "inshore aerial" surveys are used to gather effort information to adjust island-wide participation estimates. Aerial surveys were conducted twice monthly and were performed on regularly scheduled participation days (one weekday/weekend). Start times were moved up one hour for each subsequent aerial survey (0800-1200h) and repeated after reaching 1200h. Visual observations of island-wide locations (Fig. 1) included fishing effort data. The first weekday and weekend participation dates were routinely selected as the initial aerial dates due to the possibility of cancellation, e.g., poor weather conditions.

Seasonal data on the scad mackerel (atulai), goatfish (ti'ao), and jacks (i'e') were acquired through actual participation and catch surveys. Species of fish that seasonally recruit *en masse* on Guam's reefs, i.e., juveniles of rabbitfish (mañåhak), and fusiliers (Achemsom) were not entered into the database due to the sporadic nature of these fisheries.

Mañåhak en masse recruitment events are predicted to occur up to three times a year for approximately one to two weeks, depending on the overall size of the run. Recruitment events are expected to occur, the day of or days following the fourth, fifth, and tenth last quarter moon phase.

Achemsom recruitment's are irregular, but have been significant in terms of island-wide total harvest in some years.

Figure 1. Inshore Fisheries "Participation Survey" Route and Location Codes.

Atulai migrate into inshore areas throughout the year, which may cover a period lasting up to nine months. They usually enter protected locations, e.g., bays and channels, at daybreak and swim into deeper water before evening. A significant portion of the annual catch is not reported from this fishery because the larger net catches are sporadic and seldom appear on regular surveys.

Ti'ao and i'e' recruit annually on reef flats and make up a large portion of the annual catch and effort. Ti'ao generally recruit within a few days of the May full moon and during strong recruitment years, pulses of new recruitment will also follow the June and July full moons. I'e' runs also follow the full moon starting in May and can continue after each full moon through November. It is speculated that continued recruitment may be linked to continued rainfall. Past recruitment events of these species have shown to be highly significant in terms of total catch, especially *Caranx* i'e' with hook and line and *Mulloides* ti'ao with cast net, when they occur.

The FY96 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the 4th Dimension database program (4D). The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

During FY96, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 34.3 mt. Finfish accounted for 94% of total harvest or 28.3 mt (excluding mañåhak). The seasonal mañåhak catch accounted for 4.3 mt in FY96. The total inshore catch (finfish and invertebrates, excluding mañåhak) resulted from a total effort of 203,505 person-hours (ph) and 185,785 gear-hours (gh). Overall, approximately 0.16 kg/gh of fish were harvested.

Estimated participation, effort, and catch values for each fishing method are listed in Tables 1-3. The values in Table 1 are combined estimates of separate expansions of day, night, and seasonal catch data collections. Tables 2 and 3 present the participation, effort, and catch for day and night fishing respectively, for each method.

CATCH

Hook and line yielded the largest overall catch with 14.4 mt or 51% of the total harvest. Gill netting was second with 6.5 mt or 23%, while snorkel spear was third with 3.7 mt or 13%, and cast netting was fourth with 2.6 mt or 9% of the total harvest (Table 1).

Table 1. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY96.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	42,152	43,453	24,001	140,030	144,632	14,410	14,445	518	0.26 wed
Cast Net	5,405	4,695	4,616	11,699	10,190	2,603	2,582	0	0.36 wd
Gill Net	8,040	4,079	3,349	41,091	20,016	7,652	6,527	129	1.44 wd
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	3,127	2,961	1,430	7,838	7,466	4,614	3,746	949	0.90 wn
Spear Scuba	278	278	148	266	266	656	577	79	3.85 wn
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	1,037	1,482	593	1,922	2,556	80	0	76	0.05 wd
Other††	184	184	85	659	659	15	14	17	0.04 wn
TOTAL	60,223	57,132	34,222	203,505	185,785	30,030	28,273	1,757	0.16

†CPUE summary derives the greatest weekday (wd), weeknight (wn), weekend day (wed), and weekend night (wen) values from Tables 2 and 3. The greatest CPUE value for hook and line was in region 3.
††Other Methods usually include: gleaning, hand nets, traps, and spears.

The top three daytime methods accounted for approximately 97% of the daytime total and 72% of the combined total harvest (Table 2). Hook and line fishing accounted for the most fish with 12.1 mt or 57% of the day harvest. Gill netting was second with 5.8 mt or 27%, while cast netting was third with 2.6 mt or 12%, and snorkel spear was fourth with 0.6 mt or 3% of the total day harvest.

The top three nighttime methods accounted for approximately 92% of the night total and 23% of the combined total harvest (Table 3). Snorkel spear accounted for the most fish

caught with 3.1 mt or 55% of the total night harvest and hook and line fishing was second with 1.8 mt or 25%. Gill netting was third with 1.7 mt or 24% and scuba spear was fourth with 0.6 mt or 8% of the total night harvest.

Table 2. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY96.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	28,986	29,835	18,087	98,649	101,690	12,587	12,094	493	0.26 wed
Cast Net	5,405	4,695	4,616	11,699	10,190	2,603	2,603	0	0.36 wd
Gill Net	5,342	2,848	2,215	30,568	15,240	5,952	5,797	155	1.44 wd
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	968	828	551	1,876	1,563	651	626	25	0.53 wed
Spear Scuba	57	57	28	57	57	0	0	0	0.0
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	978	1,482	593	1,922	2,556	80	0	80	0.05 wd
Other††	54	54	38	129	129	1	0	1	0.02 wed
TOTAL	41,790	39,799	26,128	144,900	131,425	21,874	21,120	754	0.17

†CPUE summary derives the greatest weekday (wd) and weekend day (wed) values. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

Table 3. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY96.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	13,166	13,618	5,913	41,382	42,941	1,823	1,814	9	0.05 wen
Cast Net	0	0	0	0	0	0	0	0	0.0
Gill Net	2,698	1,232	1,134	10,523	4,776	1,700	1,700	0	0.41 wn
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	2,159	2,133	879	5,962	5,903	3,963	3,061	902	0.90 wn
Spear Scuba	221	221	120	209	209	656	577	79	3.85 wn
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	0	0	0	0	0	0	0	0	0.0
Other††	130	130	48	530	530	14	1	13	0.04 wn
TOTAL	18,373	17,333	8,094	58,606	54,360	8,156	7,153	1,003	0.13

†CPUE summary derives the greatest weeknight (wn) and weekend night (wen) values. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

EFFORT

Hook and line fishing was the most practiced fishing method based on the total participation (Table 1), accounting for 42,152 persons or approximately 70% of the total participation. Gill netting was the second most practiced method overall accounting 8,040 participants or 13% of the total participation, while cast netting followed in third with 5,405 participants or 9% of the total participation.

The rank order for day fishing participation placed hook and line first with 28,986 or 69% participants. Cast netting and gill netting placed second and third respectively with 5,405 or 13% and 5,342 or 13% of the participants (Table 2). Hook and line fishing remained the most practiced night fishing method with 13,166 participants or 72% of night participation. The second most practiced method was gill netting with 2,698 participants or 15%, while snorkel spear followed in third with 2,159 participants or 12% of night participation (Table 3).

CATCH PER UNIT EFFORT (CPUE)

Gill netting had the highest daytime CPUE of 1.44 kg/gh for weekday fishing and snorkel spear followed in second with 0.53 kg/gh (Tables 1 and 2). Cast netting was third with 0.36 kg/gh. Scuba spear had the highest nighttime CPUE of 3.85 kg/gh for weeknight fishing and snorkel spear followed in second with 0.90 kg/gh (Tables 1 and 3). Gill netting was third with 0.41 kg/gh.

The information concerning effort and harvest for methods not discussed are included in the summary Tables 1-3. Other nearshore fisheries harvests on Guam, including snorkel and scuba spearfishing off berthed and trailered boats, were recorded in the FY96 Offshore Fisheries Report (Study F-1, Job 1).

SPECIES COMPOSITION

The expanded species composition for the combined, day, and night efforts were calculated for FY96. The top non-seasonal species caught (second overall) was the scribbled rabbitfish, *Siganus spinus*, with 2.1 mt or 7.53%, while the atulai, *Selar crumenophthalmus*, was the top ranked seasonal and overall species caught with 2.2 mt or 7.81% for the combined total finfish harvest (Table 4). Carangidae ranked first with a family level harvest of 5.5 mt or 19.49% of the total finfish harvested in FY96.

Table 4. FY96 combined day and night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day and night catch (28,273 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
Selar crumenophthalmus	2,208.78	7.81	Carangidae	5,510.43	19.49
Siganus spinus	2,128.42	7.53	Acanthuridae	4,254.51	15.05
Mulloides flavolineatus	1,867.14	6.60	Mullidae	2,984.81	10.56
Acanthurus triostegus	1,789.04	6.33	Labridae	2,849.78	10.08
Caranx i'e'	1,742.60	6.16	Siganidae	2,262.93	8.00
Cheilio inermis	1,662.96	5.88	Lethrinidae	2,028.16	7.17
Lethrinus harak	1,123.35	3.97	Mugilidae	1,200.04	4.24
Naso unicornis	1,123.08	3.97	Scaridae	1,141.99	4.04
Carcharhinus melanopterus	881.00	3.12	Holocentridae	1,066.04	3.77
Cheilinus trilobatus	792.64	2.80	Carcharhinidae	881.00	3.12
TOTAL ANNUAL COMBINED CATCH	15,319.01	54.18		24,179.69	85.52

The top non-seasonal species of finfish caught for day, was the cigar wrasse, *Cheilio inermis*, with 1.7 mt (7.87%), while the atulai remained the top seasonal species with 1.8 mt (8.39%) for day. Carangidae was ranked first at the family level, with 4.6 mt (21.88%) for day (Table 5). *Siganus spinus* remained the top seasonal species of finfish caught for night, with 0.8 mt (10.66%), while the atulai topped the seasonal harvest with 0.4 mt (6.10%) for night. Acanthuridae was ranked first at the family level, with 1.7 mt (23.42%) for night (Table 6).

Table 5. FY96 combined day catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day catch (21,120 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
Selar crumenophthalmus	1,772.32	8.39	Carangidae	4,620.28	21.88
Cheilio inermis	1,662.96	7.87	Labridae	2,706.30	12.81
Mulloides flavolineatus	1,608.29	7.62	Acanthuridae	2,579.03	12.21
Caranx i'e'	1,550.94	7.34	Mullidae	2,468.76	11.69
Siganus spinus	1,365.73	6.47	Lethrinidae	1,612.10	7.63
Acanthurus triostegus	1,269.82	6.01	Siganidae	1,452.60	6.88
Lethrinus harak	1,019.62	4.83	Mugilidae	1,110.70	5.26
Carcharhinus melanopterus	881.00	4.17	Carcharhinidae	881.00	4.17
Scomberoides lysan	729.71	3.46	Holocentridae	659.38	3.12
Cheilinus trilobatus	673.59	3.19	Scaridae	496.66	2.35
TOTAL ANNUAL DAY CATCH	12,533.98	59.35		18,586.81	88.01

Table 6. FY96 combined night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total night catch (7,153 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
Siganus spinus	762.69	10.66	Acanthuridae	1,675.48	23.42
Naso unicornis	648.94	9.07	Carangidae	890.15	12.44
Acanthurus triostegus	519.22	7.26	Siganidae	810.33	11.33
Selar crumenophthalmus	436.46	6.10	Scaridae	645.33	9.02
Naso lituratus	357.68	5.00	Mullidae	516.05	7.21
Mulloides flavolineatus	258.85	3.62	Lethrinidae	416.06	5.82
Epinephelus merra	233.00	3.26	Holocentridae	406.66	5.69
Scarus frontalis	218.27	3.05	Lutjanidae	319.52	4.47
Caranx i'e'	191.66	2.68	Serranidae	257.36	3.60
Caranx sexfasciatus	183.11	2.56	Labridae	143.48	2.01
TOTAL ANNUAL NIGHT CATCH	3,809.88	53.26		6,080.42	85.01

Scuba spearfishing did not account for a significant amount of fish caught during the survey period, despite the high catch rate (personal observation) using this method. One reason for this occurrence is that a small percentage of scuba spearfishermen shore-dive at any given time, making it difficult to encounter them during an inshore catch survey. The greatest number of scuba spear interviews were obtained during the offshore surveys (Study F-1, Job 1) in FY96.

Method Harvests

The top harvest of finfish species for hook and line method was calculated for FY96 (Table 7). *Selar crumenophthalmus* ranked first, with 1.6 mt (13.23%) for day and 0.4 mt (24.06%) for night as the top seasonal species, while the top seasonal species included *Cheilio inermis*, with 1.5 mt (12.79%) for day and *Caranx sexfasciatus*, with 0.2 mt (10.09%) for night of the total hook and line harvest.

Table 7. FY96 day and night catch composition for the top ten species of finfish harvested by hook and line method. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm) are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (12,094 kg) and night (1,814 kg) hook and line catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
Selar crumenophthalmus	1,600.45	13.23	*Selar crumenophthalmus*	436.46	24.06
Cheilio inermis	1,546.33	12.79	*Caranx sexfasciatus*	183.11	10.09
Caranx i'e'	1,122.65	9.28	*Lutjanus argentimaculatus*	120.52	6.64
Carcharhinus melanopterus	881.00	7.28	*Lethrinus olivaceus*	114.57	6.32
Lethrinus harak	709.61	5.87	*Kyphosus cinerascens*	98.28	5.42
Scomberoides lysan	660.75	5.46	*Caranx* i'e'	92.74	5.11
Cheilinus trilobatus	539.93	4.46	*Myripristis berndti*	92.02	5.07
Naso unicornis	474.14	3.92	*Lethrinus harak*	77.59	4.28
Lethrinus obsoletus	371.05	3.07	*Pempheris oualensis*	71.23	3.93
Liza vaigiensis	332.49	2.75	*Lutjanus fulvus*	70.92	3.91
Total Top Ten Hook & Line Catch	8,238.40	68.12		1,357.44	74.83
Total Combined Hook & Line Catch	9,595.84	69.00			

The top harvest of finfish species for gill net method was calculated for FY96 (Table 8). *Mulloides flavolineatus* ranked first for day, with 1.6 mt (27.09%), while *Siganus spinus* ranked first for night, with 0.3 mt (16.15%) of the total gill net harvest.

The top harvest of finfish species for snorkel spear method was calculted for FY96 (Table 9). *Naso lituratus* ranked first for day, with 0.2 mt (31.77%), while *Siganus spinus* ranked first for night, with 0.5 mt (15.95%) of the total snorkel spear harvest.

Table 8. FY96 day and night catch composition for the top ten species of finfish harvested by gill net method. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. *Myripristis* spp. are listed at the genus level due to identification problems. Finfish harvest percentages were derived from the total day (5,797 kg) and night (1700 kg) gill net catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
Mulloides flavolineatus	1,570.36	27.09	*Siganus spinus*	274.52	16.15
Crenimugil crenilabis	434.44	7.49	*Mulloides flavolineatus*	239.60	14.09
Acanthurus triostegus	343.07	5.92	*Myripristis* spp.	139.81	8.22
Lethrinus harak	308.59	5.32	*Naso lituratus*	118.52	6.97
Mulloides ti'ao	295.92	5.10	*Acanthurus triostegus*	114.17	6.72
Parupeneus barberinus	224.46	3.87	*Caranx* i'e'	98.91	5.82
Liza vaigiensis	198.26	3.42	*Liza vaigiensis*	75.42	4.44
Siganus spinus	198.26	3.42	*Parupeneus barberinus*	67.59	3.98
Gerres acinaces	194.55	3.36	*Scarus psittacus*	58.30	3.43
Myripristis murdjan	153.43	2.65	*Lutjanus monostigmus*	47.57	2.80
Total Top Ten Gill Net Catch	3,921.34	67.64		1,234.41	72.61
Total Combined Gill Net Catch	5,155.75	68.77			

Table 9. FY96 day and night catch composition for the top ten species of finfish harvested by snorkel spear method. Finfish harvest percentages were derived from the total day (626 kg) and night (3,061 kg) snorkel spearfish catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
Naso lituratus	198.91	31.77	*Siganus spinus*	488.17	15.95
Siganus spinus	165.73	26.47	*Acanthurus triostegus*	405.05	13.23
Cheilinus trilobatus	76.26	12.18	*Naso unicornis*	330.66	10.80
Acanthurus triostegus	66.73	10.66	*Scarus frontalis*	218.87	7.15
Synanceia verrucosa	44.48	7.11	*Naso lituratus*	214.62	7.01
Epinephelus merra	27.20	4.35	*Epinelphelus merra*	192.17	6.28
Siganus punctatus	15.38	2.46	*Diodon hystrix*	162.33	5.30
Kyphosus cinerascens	12.07	1.93	*Balistoides viridescens*	145.54	4.75
Scarus schlegeli	11.76	1.88	*Cheilinus trilobatus*	97.12	3.17
Gerres acinaces	8.01	1.28	*Parupeneus barberinus*	93.26	3.05
Total Top Ten Spear Snorkel Catch	626.53	100.00		2,347.79	76.70
Total Combined Spear Snorkel Catch	2,974.32	80.67			

Seasonal Harvests

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The FY96 catches of i'e' and ti'ao were well represented within the expansion estimates (Tables 4 - 6), especially *Caranx* i'e'. During FY96, pulses of recruiting i'e' and ti'ao occurred from October - November, 1995. In addition, i'e' harvests occurred from May - August 1996 (primarily June and July 1996). I'e' (*Caranx* spp.) ranked fourth with 1.6 mt for the daytime harvest (Table 5) and ninth for the nighttime harvest (Table 6). Ti'ao (*Mulloides* spp.) accounted for 0.5 mt and 0.03 mt for the day and night harvest respectively in FY96.

FY96 marked a good recruitment year for mañåhak (ha'tang or *Siganus spinus* and lesso' or *S. argenteus*). Runs occurred May 8-12 and June 9-11 (Table 10) with a total estimated catch of 4.1 mt and 0.2 mt respectively. Achemsom did not run in FY96.

Table 10. FY96 mañåhak harvest during May 8-12 and June 9-11. Catch data (kg) was obtained from the following locations: Agaña Boat Basin; Asan Beach; E. Agaña Bay; Gådao-Fofos; Gun Beach; Ipan; Merizo Pier; Pago Bay; Tagachan Beach; Tipalao Beach; Togcha Beach; Tumon Bay; and Ylig Bay.

METHOD	Persons	Gears	Trips	Gear-Hrs	Catch	CPUE†
Cast Net	397	292	292	1,975	1,432	0.73
Surround Net	209	57	57	338	2,850	8.43
TOTAL	606	349	349	2,313	4,282	9.16

†CPUE summary is listed in kg/gh and reflective of actual collected data for each method.

The atulai (*Selar crumenophthalmus*) season was exceptionally successful with 2.2 mt or 8% of the total catch for FY96. Approximately 92% of the total atulai were caught with hook and line, due to the high incidence of catch interviews at the Agana Boat Basin channel (Fig. 1, location 9, and Table 7)). Other locations not represented in the inshore or offshore surveys included the following: Apra Harbor (west side) and; Agfayan, Inarajan, Pago, Talafofo, and Ylig Bays (east side). Temporary net fishing stations were established for several weeks to several months, at most east-side locations in FY96. In addition, significant amounts of atulai were harvested within the Agana Boat Basin channel using gill nets and are represented in the FY96 offshore creel results.

Invertebrates Harvested

In addition to finfish, a significant number of marine invertebrates were harvested from Guam's reefs. An estimated 1.2 mt of octopus (67% of the total invertebrate harvest) were caught island-wide in FY96. Daytime octopus harvests accounted for 0.8 mt (66% by hook and line, 21% by gill net, 11% by hooks and gaffs, and 3% by snorkel spear), while nighttime harvests accounted for 0.4 mt (81% by snorkel spear, 17% by scuba spear, and 1% by hook and line) in FY96. The skewed hook and line daytime total may have been due to the unusual encounter of incidental catches, i.e., octopus caught while bottomfishing with fish or squid for shallow water reef fish.

The second most caught invertebrate was the spiny lobster, *Panulirus penicillatus*, with an estimated 0.4 mt (24% of the total invertebrate harvest) of the island-wide catch in FY96. Nighttime lobster harvests accounted for 0.4 mt (100% by snorkel spear), while the daytime harvest was not recorded in FY96. The third most caught invertebrate was the

reef squid, with an estimated 0.04 mt (3% of the total invertebrate harvest) caught in FY96.

Spearfishing with scuba and snorkel gear accounts for a significant amount of spiny lobster, slipper lobster, and miscellaneous decapods, e.g.,*Carpilius maculatus*, harvested at night (based on personal observations by fisheries staff, Study F-1, Job 1), but these species were not significantly represented in the inshore survey estimates due to the rarity of gleaning, trapping, and spearfishing interviews.

Other methods, e.g., gleaning, trapping, and hand netting, produced an estimated 0.02 mt of finfish and invertebrates, e.g., Pomacentridae and Anomuridae, with a catch rate of 0.02 kg/ph of fishing effort.

RECOMMENDATION

Since approximately 20% of the participants and gear-units are not surveyed on the inshore participation route (based on FY96 data), it is recommended that the aerial surveys be continued. The sampling technique has improved since the initiation of the aerial surveys and an improved quantitative analysis has been done for island-wide inshore fishing effort.

Considering the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Due to the inadequacies of the "inshore-catch" survey window (especially nighttime for certain methods), harvests were not representative of the actual participation and includes the following methods for day: surround net, spear scuba, drag net, and other methods; and night: cast net, surround net, hooks and gaffs, drag net, and other methods. Methods encountered more frequently, i.e., hook and line, cast net (day only), gill net, spear snorkel, spear scuba (weekend night only), and hooks and gaffs (weekend day only), had confidence intervals less than 45% for daytime and less than 36% for nighttime fishing activity.

The increased availability and affordability of certain fishing gear methods has also changed on Guam. Hook and line has shown a significant increase since the early 1980's and has grown in popularity, especially with the i'e' and atulai fishery. Gill net use has remained high over the last decade, but the poor quality and disposability of the cheaper nets has created a situation of "ghostnetting" on our reefs. It is recommended that a change in net dimensions and duration of fishing time be made in order to reduce the overall destructiveness of this method. Scuba spearfishing has also increased with the aid of depth finders, bang sticks, and greater volume airtanks. It is recommended that certain restrictions be placed on spear scuba in order to safeguard the rapid decline of our reef fish, especially the highly reproductive adult stocks.

Overall declines in annual harvests and shifts in species composition have occurred in the last ten fiscal years. Strict measures should be taken to manage the species of fish that are steadily decreasing in the overall harvest estimates, i.e., implementation of marine preserves with adequate enforcement measures and strict land-use and fishing regulations, in order to prevent the collapse of our fishery resource.

PROJECT COST

The estimated cost of this project is $81,000.

Report prepared by: Todd J. Pitlik

APPENDIX 1

INSHORE AERIAL SURVEY

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

A total of 23 "inshore aerial" surveys were conducted in FY96 for a total of 862 persons and 777 gear units. Hook and line was the most frequently encountered method with 575 persons and 564 gear units. A ratio of participants observed in areas outside the inshore participation route to the total number for all methods surveyed during the "inshore aerial" were calculated as variables (P_2 values) for the inshore expansion. The values ranged from 63% for gill net to 100% for rare and night-practiced methods, e.g., surround net and drag net fishing.

Incidental biological sightings resulted in a total of 161 turtles, 680 dolphins, 18 sharks, and 1 ray for FY96.

BACKGROUND

Inshore fishing surveys have been conducted by the Division of Aquatics and Wildlife Resources (DAWR) since the early 1960's to monitor and collect a long-term database on the total fishing effort and catch from Guam's reefs. The "inshore-catch" and "inshore-participation" surveys were developed to collect catch and effort data in nearshore areas easily accessible by motor vehicle. In addition, the "inshore-aerial" survey was established in the early 60's and reinstated in FY90 to survey effort in areas that could not be easily accessed by a vehicle.

PROCEDURES

"Inshore-aerial" surveys were conducted twice monthly on regularly scheduled participation days (one weekday / weekend). Start times are moved up in one-hour intervals for each subsequent survey (0800-1200h), then repeated after reaching 1200h. Visual observations of areas not covered in the "inshore-participation" survey (Fig. 1: locations: 22, 27, 28, 35-39, 44-50, 58, 59, 70, and 73-92) included fishing effort data. The first scheduled weekday and weekend participation survey dates of each month were selected to allow rescheduling in the event of poor weather conditions.

Each survey started in location 11 and proceeded in a clockwise direction all the way around the island to location 12 (Fig. 1). The seaward flight distance from the reef margin was 200 -300m with an altitude of 170 - 200m. The aerial itinerary also included a semi-circular flight pattern within Cocos Lagoon and Apra Harbor. In addition, the pilot was instructed to circle over reef flat areas when it was difficult to observe or determine activity.

The aerial survey observations were sorted by method. A ratio of the methods observed in areas outside the inshore participation route were compared to the total number of persons / method observations for the island. The resultant P_2 values provided variables (%) that could be used to expand inshore participation values to island-wide participation values.

Other biological data collected, included incidental observations of marine mammals, turtles, sharks, and rays at or near the surface of various reef zones, e.g., Apra Harbor and the fore reef slope, along the aerial survey route.

The FY96 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the 4th Dimension database program (4D). The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

The most frequently encountered people / methods included hook and line, cast net, gill net, snorkel spear, and other methods, while surround net, scuba spear, hooks and gaffs, and drag net methods were less common. Ratio frequencies were highest (100%) for the least common methods, which were due to the rarity of their use during the day, e.g., scuba spear and drag net. Hook and line, cast net, gill net, surround net, snorkel spear, hooks and gaffs, and other methods (weekday and weekend days respectively) had P_2 values (Table 1) of (89 / 84), (77 / 86), (63 / 68), (100 / 85), (57 / 71), (100 / 83), and (100 / 87) respectively for FY96.

Table 1. P2 values derived from aerial survey data in FY96. Ratios were calculated from a ration of method sightings within aerial locations to participation locations. Method abbreviations are listed as follows: Hook and Line (HL; Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM).

Ratios	HL	CN	GN	SN	SpSn	SpSc	HG	DN	OM
Weekday	23/192	3/10	3/5	0/0	6/8	0/0	0/0	0/0	0/0
Weekend	59/301	7/42	21/45	6/33	10/25	0/0	3/15	0/0	6/39
WD Ratio	192/215	10/13	5/8	0/0	8/14	0/0	0/0	0/0	0/0
WE Ratio	301/360	42/49	45/66	33/39	25/35	0/0	15/18	0/0	39/45
WD P_2	89	77	63	100	57	100	100	100	100
WE P_2	84	86	68	85	71	100	83	100	87

The greatest number of people fishing in participation areas during the aerial survey used hook and line on weekdays and weekends for a total of 493 and 486 persons and gear units respectively, while hook and line was also the most frequently used method in aerial areas for a total of 82 and 78 persons and gear units respectively for FY96 (Table 2).

Dolphins topped the list of the most frequently sighted marine animals during the aerial surveys with the greatest monthly total of 185 sightings in August and an annual total of 680 sightings in FY96 (Table 3). Turtles and sharks ranked second and third respectively with an annual total of 161 and 18 sightings. The greatest monthly total of turtles were sighted in May and August with 23 and sharks in April with 9. One ray was sighted in April.

Table 2. Total number of people and gear units observed during aerial surveys in FY96. Method abbreviations are listed in Table 1 with weekday (WD) and weekend (WE) listed below.

	Within Par Route				Outside Par Route			
	Persons		Gears		Persons		Gears	
Methods	WD	WE	WD	WE	WD	WE	WD	WE
HL	192	301	190	296	23	59	23	55
CN	10	42	7	39	3	7	3	6
GN	5	45	5	19	3	21	2	11
SN	0	33	0	8	0	6	0	1
SpSn	8	25	8	25	6	10	6	10
SpSc	0	0	0	0	0	0	0	0
HG	0	15	0	15	0	3	0	3
OM	0	39	0	39	0	6	0	6

Table 3. Number of turtle, dolphin, shark, ray sightings in FY96.

	MONTHS												
SPECIES	O	N	D	J	F	M	A	M	J	J	A	S	TOTAL
Turtle	7	5	22	9	9	0	14	23	19	10	23	20	161
Dolphin	30	50	15	15	45	0	40	80	45	115	185	60	680
Shark	0	0	0	0	4	0	9	4	1	0	0	0	18
Ray	0	0	0	0	0	0	1	0	0	0	0	0	1

FLIGHT COST

The cost of this project was $9,500.

Report prepared by: Todd J. Pitlik

APPENDIX 2

KID'S FISHING DERBIES

PERIOD COVERED: 1 October, 1995 to 30 September, 1996

SUMMARY

A marine fishing derby for kids only was held in FY96 in cooperation with U.S. Naval Activities. This event, held at Dadi (Old Wives) Beach, was to be a two-day event open to 150 different participants, or 75 kids per day. However, a total of 75 participants signed up for the two-day event, so the derby was shortened to a one day event. This was the fourth marine derby sponsored by the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR). In previous years, three freshwater derbies have been co-sponsored by DAWR and U.S. Naval Activities.

OBJECTIVE

To encourage fishing as a form of recreation for children by promoting at least two kids fishing derbies per fiscal year, and to use these events as opportunities to teach environmental and fishing conservation ethics.

PROCEDURES

1) Coordination of derby logistics.

2) Purchase and installation of advertisement banners and media coverage.

3) Certificates of Participation, fish posters, and prizes for all derby participants.

4) Interagency cooperation.

5) Derby rules and clinic.

Logistics

Logistics had to be planned and coordinated to ensure that the event ran smoothly on derby day. This involved setting up and taking down the staging and rest area, providing refreshments, organizing staff to serve as officials, organizing a safety briefing prior to and an awards ceremony after the event, and ensuring that official representatives from both agencies were present for the awards presentation. Coordination of the event involved preparation and planning at least 4-6 weeks in advance. A fishing site had to be selected that provided safe shoreline fishing for the participants and habitat for fish. A date had to be selected to ensure a high tide during the fishing event to increase the chances of catching fish.

Advertising strategy needed to be coordinated to ensure maximizing derby exposure to children ages seven to twelve both on and off base. Flyers were provided to all elementary and middle schools, highway banners were purchased and posted in strategic areas, providing the media with press releases periodically, and making derby pitches through various radio talk shows.

Kids fishing derbies held in cooperation with military installations had individuals from both agencies serving as points of contact. This ensured that requirements of both agencies were met and that duties assigned to each agency were completed. Leslie Morton of the U.S. Naval Activities Environmental Office and DAWR Fisheries Biologist Thomas Flores were the designated points of contact for this kids derby.

Derby Rules, Clinic, and Prizes

The derby had a size limit and a bag limit to provide participants an opportunity to exercise conservation. Fish had to be over 6 inches (154 mm) in length in order to count towards a point system and which could be kept. Although there was an individual bag limit of five fish, participants were encouraged to practice "catch and release" during the event. The derby was open to children from seven to twelve years of age, and was preceded by a fishing clinic open to the public on June 15, 1996.

The fishing clinic provided an opportunity for parents and children to practice basic fishing skills including knot-tying and casting. Demonstrations were also conducted to aid parents in selecting and purchasing fishing gear and in preparing for the fishing event.

Certificates of Participation and fish posters were provided to all participants. A draft post-derby report has been completed which includes comments and suggestions from derby participants to improve future derbies.

RESULTS

The derby was initially scheduled for June 15-16, but was rescheduled for the weekend of June 22-23 to avoid conflicting with Father's Day on June 15. This derby experienced the lowest number of registrants despite extending the regisuation period to June 18. Since only 75 participants signed up, the derby was shortened to a one day event, held on June 22. Fifty-eight children actually participated in the event. Prizes for the derby were solicited for a two day event, with thirty-five prizes being donated. Since there were only six winners from the actual fishing, the remaining prizes were distributed by lottery to the non-winners. Food was also donated by businesses, with sandwiches being provided as refreshments. Some technical assistance was given to the Department of Parks and Recreation for their 2nd annual Governor's Cup I'e Fishing tournament. Unlike last year when DAWR staff participated as shoreline judges, DAWR staff conducted only the Safety Briefing for this event.

RECOMMENDATIONS

To increase the number of participants, advertising needs to be improved to actively target more potential participants. The number of ads placed in the local newspaper was reduced from two to one since highway banners were used for the first time. Highway banners are posted for one month, which is easier and more effective than newspaper ads. Advertising on the school level needs to be increased and improved since this is the preferred avenue to target the derby age group. The use of mini flyers was an excellent idea, although providing one to each child in the private and public schools involves a substantial amount of paper and work. Mini-flyers, however, are an improvement over providing a single flyer per classroom.

The response from the participants and parents was positive. However, participants at the upper end of the age requirement are requesting that the age category include teenagers to continue their participation in the derby. Also, parents have requested that the one-participant one-guardian rule be more flexible to allow both parents to be in the event. This

may increase derby participation and eliminate the unpopular practice of turning away participants not adhering to the one-participant one-guardian rule. This flexibility should be considered depending on the available shoreline area of the fishing site. Additional safety measures would have to be considered and enforced to ensure that these events remain injury-free.

One of the categories for the marine derbies has been emperors (mafute and lililok), fish primarily in the genus *Lethrinus*. However, emperors are rarely caught during these derbies, resulting in these prizes being distributed by lottery. This has brought about a concern that these prizes should be awarded to fourth or fifth place winners in the other two categories. Choosing a fish group that is commonly caught in these events, such as triggerfish, wrasses, or even goatfish would eliminate this concern and award prizes to participants actually catching fish.

Kid's derbies co-sponsored with U.S. Naval Activities have been previously held at Fena Lake. This provided participants with a freshwater fishing experience. Having a kid's event at Fena Lake during the next fiscal year will be pursued.

This report was Prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-4
SUB-PROJECT NO: F-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Freshwater Monitoring (2440)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

During FY96, a watershed stream sampling survey method was implemented. The four previously selected watersheds were sampled two times. Faunal counts and basic observations have been summarized. Comparative analysis will not be possible until a second year of data has been collected.

The tributaries above Fena Lake and the drainage below continue to be assessed to determine the influence of the dam on migrating fauna. The results of the study should be completed during FY97.

Six other streams were visited during FY96 and a database of aquatic species sighted has been started.

BACKGROUND

Maintaining high quality watershed ecosystems is essential to protecting healthy coastal areas which support fisheries. In order to maintain the quality of Guam's watershed ecosystems, baseline data must first be collected which includes identifying the aquatic species residing in these ecosystems, determining their densities, the physical characteristics of the streams, and the quality of the water. Monitoring these parameters will support watershed management and thus ultimately protect Guam's coastal resources.

Although various watersheds have been monitored for different parameters, in general Guam's freshwater resources are not well studied. The methods of monitoring have seldom been replicated, making comparisons or management as a whole unrealistic. In the past ten years the island has experienced a rapid pace of development. Some existing and some proposed developments, such as golf courses/resorts, are located in some of the island's larger watersheds. There exists very little baseline data by which to assess potential impacts of proposed development to streams, lakes, and coastal areas and therefore impact assessment has been difficult without extensive study and mitigation recommendations remain problematic. Some development projects within the last 10 years have significantly degraded watershed quality, which has resulted in large losses of coastal coral reef habitat. Additionally, most existing work has been completed by off-island consultants over the short term using techniques developed for temperate areas and not applicable in their entirety to Guam's tropical freshwater systems.

The work performed during FY96 was devoted to two projects which will be used to help implement a long term watershed monitoring program. Four watersheds were selected at

the beginning of FY96 for a short term monitoring program: 1) Fena; 2) Manenggon; 3) Ylig; and 4) Pago. These were selected because they represent a range of watershed characteristics that may help to determine the impacts of the present and proposed land uses and provide the monitoring parameters necessary for a management plan.

The short term nature of this project was to develop a technique to survey aquatic fauna to allow statistical comparisons within and between watersheds to establish a baseline data base to monitor watershed health. It has been shown that visual surveys are effective in estimating fish abundance in small streams (Hankin and Reeves, 1988; Moyle and Baltz, 1985) like the ones found on Guam. One such method is the Modified Point Quadrat (Baker and Foster, 1988), a survey protocol that has been used in Hawaii (Nishimoto and Kuamoo, 1991), Guam (Parham, 1995) and elsewhere in Micronesia (Parham, 1995; Nelson et al., 1995). The Modified Quadrat technique was field tested in FY95 in the chosen watersheds and determined to be feasible for the initial FY96 study.

In addition to the watershed management issue a second aspect of this job was to address the concern over the impact that man-made dams or lakes have on watersheds. Economic development on Guam, as in the Pacific island region in general, is rapidly increasing the demand for water. As the population increases so does the demand on ground water resources. Current plans are to develop surface water resources through the construction of reservoirs on several of Guam's rivers. There is currently only one large man-made reservoir on Guam; this is the Fena Dam/Reservoir that was constructed by the U.S. Navy in 1951.

Many of the ecological aspects of Guam's inland aquatic species are poorly known. However, reservoirs could present a migration barrier and affect the distribution and reproductive success of freshwater fauna in the streams that drain into them. Stream fauna in oceanic islands consists of a limited number of species whose ancestors invaded from marine sources (Maciolek and Ford, 1987). All of the indigenous, non-insect macrofauna of the streams of Guam are diadromous, spending part of their life in the sea and part in freshwater (McDowall, 1992). Thus, for species to exist above reservoirs, they must have access to the marine environment especially during the migration periods of adults, juveniles, and larvae.

The reservoir and the dam could pose a barrier to diadromous species making their way up to the streams above the reservoir for several reasons. One, the reservoir is home to several species of fish that could prey upon migrating larvae and juveniles. Second, some of the gobioid fishes have specialized pelvic fins that allow may allow then to transverse the spillway whereas others are not adapted to climbing. Third, when the spillway is dry, or conversely if water is flowing too rapidly over the spillway, some species may not be able to get past the dam.

In the past the Department has reviewed proposals for the placement of dams in Guam's rivers. Unfortunately, adequate data was not available to assess the potential impacts such structures would have on the indigenous aquatic macrofauna. Instead, private consultants gathered data using survey techniques that had not been field tested to work in small tropical watersheds. Based on these past experiences, the need for consistent sampling protocols, and the need for baseline data (of aquatic macrofauna) it was decided to carryout a project to address these aspects.

This project is part of the initial study started in FY95. The three streams above Fena Reservoir were sampled in addition to the four streams selected to test the Modified Quadrat Technique. All seven rivers are part of the four watersheds selected for the initial study.

The data collected from the three streams above Fena (affected) will be compared with the data collected in the four streams in each of the respective watersheds (unaffected/control) chosen to test the Modified Quadrat Technique. The data of the affected streams will be compared with the data collected in the control streams. If the reservoir is a barrier to macrofauna migration, then species composition and densities should be different from the control streams.

This project also serves as a Master of Science thesis project for the program coordinator under the University of Guam's Graduate Biology Program.

OBJECTIVES

1. To compile both local watershed information and relevant related literature available for Guam watersheds and the monitoring and management of such systems; and to develop a list of watershed information needs, prioritize needs and pursue separate program development to obtain needs.

2. Develop and test sampling/survery technique.

3. Collect baseline macrofauna, etc. data on representative streams.

4. Determine the role of dams/reservoirs as barriers to reproduction of freshwater macrofauna.

PROCEDURES

During a FY95 literature survey, a list of local watershed information and relevant literature available for Guam was collected both from local and off-island sources. Simultaneously, suitable monitoring techniques were also researched. This information was used to develop a scope of work for development and implementation of a long-term freshwater monitoring program. Four watersheds were selected for the initial monitoring program and the testing of a survey technique. Fena Reservoir and its tributaries are part of one of the watersheds chosen for the initial study

Species composition and species density data was collected in the four selected watersheds using the Modified Quadrat technique. In addition to species composition and species density, several environmental parameters were measured to their role in determining species composition of stream macrofauna and to gather information regarding the physical characteristics of the stream. The water velocity at each quadrat was measured in the center of the quadrat at 60% of the maximum depth. The readings taken during this period were averaged. A Flo-Mate portable flowmeter Model 2000 was used to measure water velocity and a wading rod was used to measure water depth. The two dominant substrate types and their percent makeup were recorded for each quadrat. The Helm, et al. (1985) classification system was used to categorize substrate types as either bedrock, boulder (>256 mm), cobble/rubble (64-256 mm), gravel (5-64 mm) or sand/sediment (<5 mm) by diameter.

A total of 200 meters in twenty, ten meter sections of each stream were sampled. The location of the 200 meter segment within the stream was chosen haphazardly. One quadrat was located within each of twenty 10 meter segments of each stream. The location of the quadrats each 10 meter segment was chosen randomly. A total of twenty sample quadrats per stream was determined to be necessary for a statistical reliability of at least 80%. A ten-meter segment was measured parallel to the stream then a number between 0 and 9 drawn from a bag (0-9 as representing one meter segments along the transect). This number

marks the first point along the length of the stream. Standing at that first point, the width of the stream was measured with a range finder and another number between 0 and 9 chosen from a bag, represents the percentage of the width where the quadrat was to be located. The observer then conducted a visual survey at this location.

Upon reaching the selected area, the observer chose a spot for viewing and then located objects within the stream to mark the corners of the rectangular quadrat. It is important that the size of each quadrat be limited to an area in which visual observation is possible, therefore the quadrat size was between 1.0 m^2 and 2.0 m^2. Two minutes were allowed for the organisms to settle back into the area prior to counts being made, due to disturbances made by the observer moving into place. Observations were made from the stream bank or in the water with a snorkel and mask. The observer noted how many of each organism were seen within the quadrat. All macrofauna, including fish, prawns, snails and shrimp were recorded to the species level during the survey.

After all the organisms were counted, the size of the quadrat was recorded. A surveyor tape was used to measure the length and width of each quadrat; and from these measurements, the area calculated to determine species density.

To address the question of watershed impacts resulting from man-made dams or lakes, additional surveys were conducted within Fena Reservoir using snorkel and mask. The areas to be surveyed are along the banks of the reservoir that are shallow enough to allow the observer to see the bottom. The results of this particular survey will be recorded as absence or presence for each species.

Analysis of Variance will be applied to determine if there are differences among affected and control streams in the densities, i.e., the number of individuals per square meter, of each of the species that are abundant enough for meaningful analysis. A similar ANOVA design will be used to compare the species densities, i.e., the number of species per square meter, between affected and control streams.

RESULTS

Data were collected in the dry season of FY96 but have yet to be analyzed statistically. It is necessary to collect additional data during the next dry season (February through June 1997) before any conclusions can be made regarding whether or not the Modified Quadrat technique can be applied in all of Guam's rivers to obtain statistically sound species abundance estimates and if Fena Reservoir affects the distributions and densities of macrofauna of the three affected streams.

The control streams are Manenggon, Ylig, Pago, and Maagas (below Fean Dam). The affected streams above Fena Reservoir are Maulap, Almagosa, and Sadog.

Preliminary data are reported in Table 1 as densities (organisms per square meter). An entry of zero represents no organisms were present at the site sampled. The densities recorded range from 0 to 26.3 organisms per square meter. These densities appear to vary greatly, however, it must be recognized that these organisms need specific habitat types and may not be randomly dispersed throughout the stream. Also, because sampling is random, some habitat types may not have always been sampled. In addition, because Guam's streams are relatively small, the macrofauna densities may appear to be fairly high compared to larger streams, because the macrofauna have limited area in which to disperse.

Table 1. FY96 Dry season macrofauna stream densities (organisms/m^2) determined using the Modified Quadrat Technique.

Site	Manenggon	Ylig	Pago	Maagas	Maulap	Alamagosa	Sadog
1	21.2	3.5	4.4	2.6	0	5.7	0
2	14	1.4	0	3.1	0	2.1	0
3	6.2	1.3	2.3	13	1.7	1.6	0
4	6.3	0.7	1.3	7.2	3.5	0	3.7
5	13.2	11.6	0	3.2	0	2.9	2.8
6	13.4	1	0	5.6	1	0	0
7	8.5	3.4	4.7	3.8	0	1.7	0
8	2.9	3.5	0	7	2.7	0	0
9	5.6	2.9	4.3	23.5	2.5	0	0
10	1.1	4.3	1.1	10.7	3.4	0	0.7
11	4.7	5.3	4.1	26.3	0	0.7	1.7
12	3.1	1.3	3	4.8	0.007	0	0.82
13	1.4	3.4	0.5	7.3	4.7	0	0
14	0	2.2	0.6	1.8	1.7	0.5	0
15	0	1	5.5	0	0.74	2.4	0
16	14.3	0	0.84	3.4	10	0.002	1
17	3.5	1.2	5.7	11.8	5.5	0.9	0
18	2.2	1.9	19.1	2.3	2.9	0	0
19	4.2	0	2.1	2.9	3.2	0	0
20	4.8	6	3.2	2.6	0	0.7	1.3

A total of 60 days were spent in the field. Approximately 75% of these days were devoted to the initial study and the Fena project, and the remaining 25% were devoted to identifying species residing in other rivers not associated with the initial study and Fena. A log of species identified in all rivers visited during FY96 has been started and is available upon request.

RECOMMENDATIONS

This is the second phase in developing a long-term freshwater monitoring and management program. Recent degradation of watersheds has resulted in the loss and destruction of coastal reef habitat. Maintaining high quality watershed ecosystems is essential to protecting healthy coastal areas, which support sport fisheries. It is recommended this project be continued and the stream monitoring program expanded to include more of Guam's freshwater systems. Once sufficient data has been collected, analysis should be directed toward developing a watershed management plan. This should be integrated with existing island-wide water monitoring and coral reef protection. In conjunction with the survey technique selected, studies of macrofauna behavior should be developed to help explain survey abnormalities.

PROJECT COSTS

Estimated Project Cost: $55,000.

This report was prepared by: Georgette Bello Concepcion.

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JOB PROGRESS REPORT
COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-4
SUB-PROJECT NO.: F-3
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish Resources (2710,2720)

PERIOD COVERED: October 1, 1995 to September 30, 1996

BACKGROUND

Professional Fisheries Staff from the Division of Aquatic & Wildlife Resources (DAWR), devoted a significant percentage of their time and effort to technical assistance to fulfill the statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments, the Fisheries Staff's review responsibility requires a continuing commitment that could extend even beyond project completion.

The Division's Technical Assistance Program (TAP) within the Administration and Coordination Section continues to handle the majority of the technical assistance. A local appropriation provides funding for a technical assistance staff a Biologist II. He is primarily responsible for reviewing projects submitted to the Development Review Committee for action by the Territorial Land Use Commission and for the review of clearing and grading permit applications, but they also participate in the review of other permit applications and environmental documentation. The professional staff within the Fishery Section provide technical support to the TAP staff, and occasionally take the lead in the review of projects involving their particular expertise, such as those that may have endangered species (sea turtles) impacts and those involving coral reefs.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.

2. Provide technical assistance to military and civil agencies relative to the management and protection of fish resources.

FINDINGS

Fisheries Staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Fisheries Staff members actively serve as members of the following groups:

1) Recreational Water Use Master Plan

2) Western Pacific Regional Pelagic Plan Monitoring Team

3) Western Pacific Regional Bottomfish Plan Monitoring Team

4) Western Pacific Regional Scientific and Statistical Committee

5) Federal Data Coordinating Committee

6) The Coral Reef Initiative

7) Oiled Wildlife Subcommittee of the Area Committee for Oil Spills.

Members of the Fisheries Section attended 52 meetings and made 21 field inspection during FY96 pertaining to the protection of Guam's natural resources. Additionally, staff have continued to actively consult with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service, Western Pacific Regional Fisheries Management Council, National Marine Fisheries Service, U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Fisheries Staff during the reporting segment. In addition to occasional interviews on radio, television, and in the newspaper, they also gave talks to a number of civic groups, and schools.

Some specific Technical Assistance activities provided by the Fisheries Section included:

1) Technical staff continued to invest considerable time in monitoring and evaluating the environmental impacts associated with the Piti Underwater Observatory (PUO). This included extensive photographic review of corals transplanted and determinations of damage. Regular field inspections were made to ensure construction work was complying with permit requirements.

2) Technical support to the Divisions TAP staff who represents the Department and the Division on the Development Review Committee, which met biweekly to review applications for rezoning, variances, and various types of development.

3) Offered comments and provided information to the Western Pacific Regional Fisheries Management Council (WESPAC) and the Plan Monitoring Team (PMT) on projects for bottom and pelagic fisheries. Information was provided on market sampling, and stock assessment, and from recreational and near-water commercial vessels. Staff attended 5 off-island, Council related meeting.

4) Reviewed and commented on seven proposed bills that would affect fisheries.

5) Investigated five suspected fish kills in island waters during the year.

6) Responded to eight requests for information on laws and regulations pertaining to fish, endangered species, fishing and importation of fish.

7) Made 19 presentations on fish resources to other organizations or groups during the year.

8) Twelve staff provided 8 hours each of assistance per day over the three-day Guam International Fishing Derby.

9) Provided statistical data on fisheries issues to the Bureau of Planning and Department of Commerce on a quarterly basis.

10) Attended seven meetings with the developer, nine meetings with the Guam Environmental Protection Agency, and made eight field inspections to provide additional review and comment on the revised proposal to construct an underwater observatory on the Piti reef flat.

RECOMMENDATIONS

This project needs to continue to support the TAP.

PROGRAM COST

The estimated cost of the Technical Assistance project under F-1R-4 is $28,000

Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-1R-4
SUB-PROJECT NO: F-3
STUDY NO: 3
JOB NO: 1

STUDY 3: Studies of Guam's Recreationally-Important Fish (2450)

JOB TITLE: Biology of *Lethrinus harak* and *L. obsoletus*

PERIOD COVERED: October 1, 1995 to September 30, 1996

OBJECTIVE

To investigate the need for management of Guam's recreationally important fish through analysis of fishing pressure, population dynamics and life history studies.

PROJECT SUMMARY

Field collection of *Lethrinus harak* and *L. obsoletus* resumed in December of 1995 as part of an effort to establish fecundity estimates for each species. The intended scope of work for FY96 was to: 1) collect at least one ripe female specimen of each species for every 10mm size-class category beginning at the 170mm size-class; 2) conduct appropriate laboratory procedures to obtain pertinent data for each specimen collected; and 3) process the data using applicable statistical analyses to determine fecundity. To improve the chances of catching the maximum number of ripe females, collection trips were scheduled to coincide with the beginning of each lunar month because both *L. harak* and *L. obsoletus* are reported to spawn within five days after the new moon (Carpenter & Allen, 1989).

Lethrinidae collection at the Cocos Lagoon study site, however, was abandoned soon after the first month of effort due to difficulties in obtaining sufficient numbers of the larger specimens. Of the five field trips conducted in December 1995, seventeen specimens were collected; the longest of which was 266mm (Table 1).

Analysis of inshore creel survey data for the historic total annual islandwide harvests of *L. harak* and *L. obsoletus* since 1985 (Figure 1) suggests that the decline in the populations of these species may not be unique to Cocos Lagoon, and that both stocks are likely already being harvested at or above their respective maximum sustainable yield (MSY) island-wide. Furthermore, although both species are reported to average between 200-300mm in length and attain a maximum length of between 500-600mm (Carpenter & Allen, 1989), the average lengths calculated for measurements recorded between FY85-86 and FY92-95 were 205mm for *L. harak* and 200mm for *L. obsoletus* (Figure 2).

Recognizing that additional time and manpower would be needed to collect and process the numbers and sizes of *L. harak* and *L. obsoletus* necessary to establish statistically-reliable fecundity estimates, the decision was made in January 1996, to suspend further allocation of resources to field and laboratory work until a method could be identified to efficiently collect and process the numbers needed to complete the studies.

Table 1. FY96 Biological data collected on *Lethrinus harak* and *L. obsoletus*.

Date Caught	Specimen ID No.	Species	Length (mm)	Total Wt. (g)	Gonad Wt. (g)	Aliquot Wts. (g)	Gonad Stage*
12/09/95	9	*L. harak*	266	403.0	28.236	a. .878 b. .784 c. .860	4
	10	*L. obsoletus*	247	314.0	17.034	a. 1.012 b. .934 c. 1.199	4
12/20/95	7	*L. obsoletus*	255	340.0	6.438	a. 1.079 b. 1.139 c. 1.106	3+
	8	*L. harak*	212	191.0	2.414	a. .610 b. .688 c. .946	2+
12/21/95	1	*L. harak*	256	348.5	11.214	a. .709 b. .760 c. 1.071	4
	2	*L. harak*	239	239.0	3.851	a. .880 b. .545 c. .820	3
	3	*L. harak*	261	261.0	7.394	a. .660 b. .681 c. .756	4
	4	*L. harak*	233	233.0	4.861	a. 1.042 b. .970 c. .741	3+
	5	*L. harak*	213	213.0	2.027	a. .576 b. .466 c. .543	2+
	6	*L. harak*	202	202.0	1.170	a. .417 b. .294 c. .384	2+
12/23/95	15	*L. harak*	240	265.0	6.000	n/a	n/a
	16	*L. obsoletus*	255	306.0	11.000	n/a	n/a
	17	*L. obsoletus*	263	352.0	22.000	n/a	n/a
12/26/95	11	*L. obsoletus*	246	286.0	10.371	a. .428 b. .269 c. .412	4
	12	*L. obsoletus*	235	253.0	2.654	a. .415 b. .352 c. .309	3
	13	*L. obsoletus*	222	232.0	3.928	a. .416 b. .490 c. .384	3
	14	*L. obsoletus*	231	257.0	13.499	a. .570 b. .540 c. .638	4

***Gonad stage**

Stage 1: gonad beginning to develop, eggs not visible
Stage 2: gonad more developed; eggs becoming visible
Stage 3: gonad mostly developed, some eggs visibly ripe
Stage 4: gonad fully developed, most eggs visibly ripe

Given the evident declines in population and the more immediate concern of overfishing of all Guam's reef fish (Figure 1), the project to study the biology of *L. harak* and *L. obsoletus* was subsequently terminated to allow focus of future sport fish investigation efforts to shift towards the pursuit of management options such as the establishment of marine preserves.

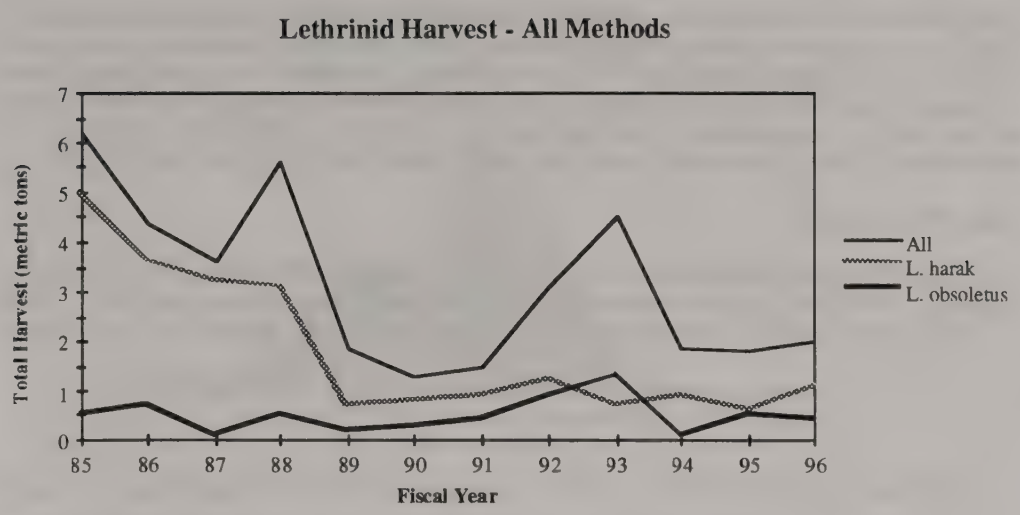


Figure 1. Lethrinidae harvest for all methods from Guam's Inshore Creel Data.

STUDY RESULTS (FY85-86 and FY92-96)

The study of *L. harak* from FY85-86, and both *L. harak* and *L. obsoletus* from FY92-96, included investigations of size distribution, sex ratio, spawning seasonality, lunar occurrence of spawning activity, growth rate and historic harvest analysis. The following provides a brief background of the study of the two emperor species and a summary of the findings and results for each of the above-mentioned parameters:

Background

The family Lethrinidae (emperors) are close relatives of snappers but differ primarily by having a maxillary completely hidden by a bare or near-bare preopercle and conical or molariform teeth on the sides of the jaws. Lethrinidae also have fairly thick lips, canine teeth towards the front of the jaws, a continuous dorsal fin with X spines and 9 to 10 rays, and an anal fin with III spines and 8 to 10 rays (Myers, 1991).

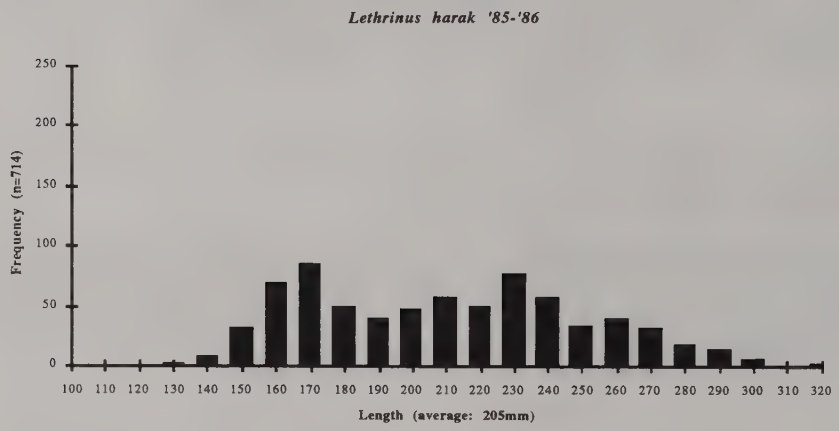
Lethrinus harak, commonly known as the blackspot or thumbprint emperor, inhabits mangroves, coral rubble, shallow sandy lagoons, channels and seagrass areas adjacent to coral reefs. It feeds on crustaceans, molluscs, polychaetes, echinoderms and small fishes, and grows to maximum total length of about 500mm, but more commonly to between 200 to 300mm. *L. harak* have been reported to spawn in large aggregations year-round during the first five days of the lunar month in the lagoons of Belau (Carpenter & Allen, 1989). *L. harak* has been observed by fishermen to burrow in the sand which may serve as a means of escaping their predators and drag nets (Schroeder, 1980).

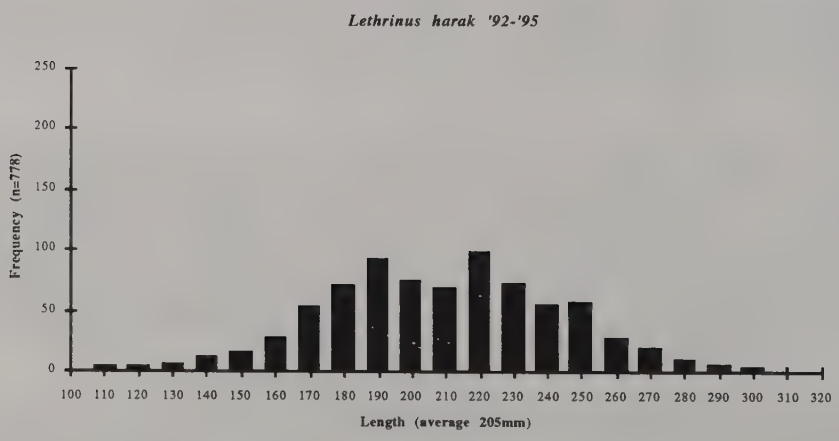
Lethrinus obsoletus, commonly known as the orange-striped emperor, is also found in seagrass beds and sand and rubble areas of lagoons and reefs. Much like *L. harak*, *L. obsoletus* feeds primarily on crustaceans, molluscs and echinoderms, and grows to about 200 to 300mm with a reported maximum size of 600mm. In Belau, spawning is reported to occur at the outer reef edge during the first five days of the lunar month between November through April (Carpenter & Allen, 1989).

L. harak was the original species selected for study because of its cultural significance as a food fish and popularity as a recreational catch. However, after preliminary analysis of catch and tag and release totals for FY92 revealed that *L. obsoletus* was being caught more frequently than *L. harak*, the project was expanded in FY93 to include *L. obsoletus* as part of the study. In addition to sharing much in common biologically, culturally and recreationally, both appear to be equally susceptible to current fishing pressures as well.

Size Distribution

The length-frequency distributions for *L. harak* (FY85-86 and FY92-95, n=1,492) and *L. obsoletus* (FY92-95, n=1,394) have been completed and the results are depicted in Figure 2. The average lengths calculated were 205mm for *L. harak* and 200mm for *L. obsoletus*.





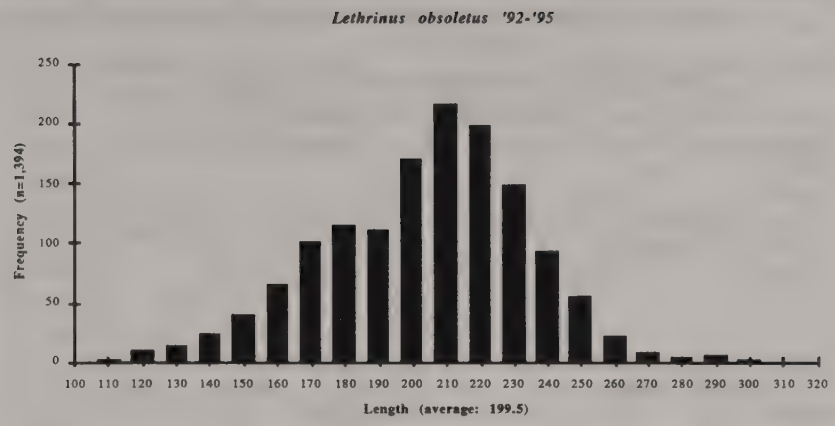


Figure 2. Length-Frequency Charts for *Lethrinus harak* ('85-'86 and '92-'95) and *L. obsoletus* ('92-'95).

Sex Ratio

Chi-square goodness of fit tests were conducted with the conclusion that both species exhibited a one-to-one sex ratio, even at the later stages of their life history. Table 2 lists the results for each data set, which includes separate tests for the larger (upper 25%) size classes to rule out the possibility of sequential hermaphroditism.

Spawning Seasonality

L. harak reportedly spawns year-round while *L. obsoletus* spawns from November through April (Carpenter & Allen, 1989).

Carpenter & Allen (1989) also report that *L. harak* and *L. obsoletus* spawn during the first five days of the lunar month. The primary difference between the two, however, is that *L. harak* reportedly spawns in lagoons while *L. obsoletus* spawns at the outer reef edge.

Fecundity

Methodology and procedures to obtain fecundity data were resumed in FY96. However, the combined number of specimens of each species sampled between FY85-86 and FY92-96 were insufficient for establishing a statistically reliable fecundity estimate.

Tag and Recovery

Between FY92-95, 681 *L. harak* and 1,147 *L. obsoletus* were tagged and released. Only 5 *L. harak* (0.7%) and 15 *L. obsoletus* (1.3%) were recovered during this time period. The time from tag and release to recovery ranged from 14 to 133 days for *L. harak* (avg: 78 days) and 15 to 111 days (avg: 51 days) for *L. obsoletus*.

Analysis of Lethrinid tag recoveries suggest that both, *L. obsoletus* and *L. harak,* may have some temporal tendency to be resident to specific sea-grass areas in Cocos Lagoon. Of the twenty-seven tagged fish recovered, all were made within a half-mile radius of where the fish were originally caught and tagged, and usually less than three months from the time of tagging (the oldest tag recovery being a little over four months from the date the fish was tagged).

Table 2. Chi-Square Tests for 1:1 Sex Ratio

L. harak '85-'86

All Size Classes: 120-320mm			Upper 25%: 240-320mm		
	Female	Male		Female	Male
Actual	475.0	148.0	Actual	136.0	61.0
Expected	311.5	311.5	Expected	98.5	98.5
n=623		n=197			
d.f.=1		d.f.=1			
chi test	3.2504E-39		chi test	9.1154E-08	
.975>probability>.900			.975>probability>.900		

L. harak '92-'95

All Size Classes: 110-300mm			Upper 25%: 230-300mm		
	Female	Male		Female	Male
Actual	85.0	52.0	Actual	50.0	42.0
Expected	68.5	68.5	Expected	46.0	46.0
n=137		n=92			
d.f.=1		d.f.=1			
chi test	0.004811648		chi test	0.404248496	
.975>probability>.900			.900>probability>.500		

L. obsoletus '92-'95

All Size Classes: 110-300mm			Upper 25%: 230-300mm		
	Female	Male		Female	Male
Actual	97.0	157.0	Actual	39.0	23.0
Expected	127.0	127.0	Expected	31.0	31.0
n=254		n=62			
d.f.=1		d.f.=1			
chi test	0.00016673		chi test	0.04215346	
.975>probability>.900			.900>probability>.500		

Growth

Given the low rate of tag recoveries and the short duration of time between tag and recovery (less than 4.5 months), it is not clear that the growth data collected from the tagging effort will yield reliable growth rates for these Lethrinids, especially in light of the fact that these fish are reported to reach an age of 14 to 15 years and a maximum size of 500 to 600mm (Carpenter and Allen, 1989).

Historic Harvest Analysis

Figure 1 illustrates the FY85-96 harvest trends of Lethrinidae on Guam at both the family and species level. The estimates are based on computer-generated expansions of the Guam inshore creel survey data.

RECOMMENDATIONS

In light of harvest trends showing significant declines of Lethrinid harvests at both the family and species levels (Figure 1), as well as an alarming decrease in the harvest of all finfish caught by hook and line, despite increased gear hours for the same method (Figure 3), a separate sub-project should be established under Guam Sport Fish Investigations to shift the focus of investigative efforts towards immediate implementation of management

measures. The project to study the biology of *L. harak* and *L. obsoletus* should thus be terminated to allow reallocation of resources to management pursuits.

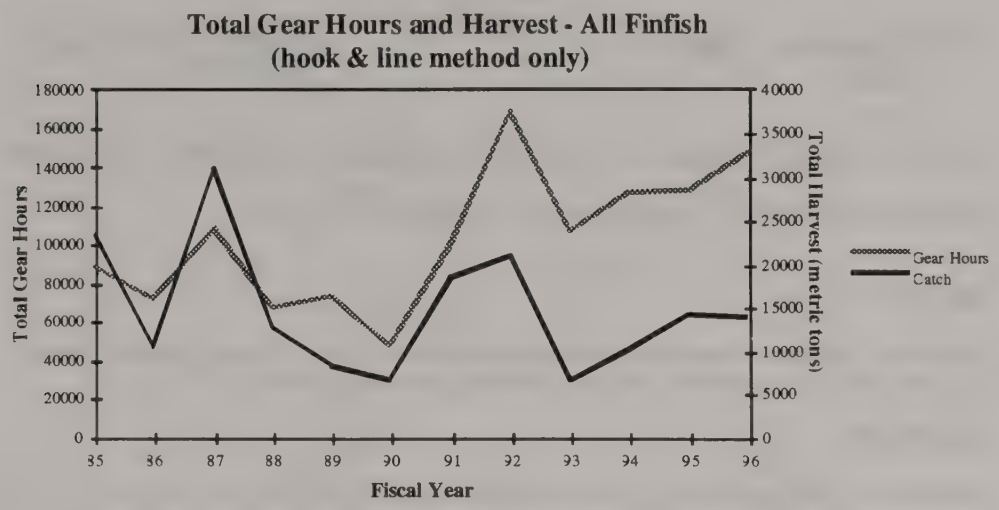


Figure 3. Finfish harvest with hook and line only from Guam's Inshore Creel Data.

LITERATURE CITED

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Myers, R.F. 1991. Micronesian Reef Fishes. Coral Graphics, Guam. pp.143-147.

Schroeder, R.E. 1980. Philippine Shore Fishes of the Western Sulu Sea. National Media Production Center, Manila, Philippines. pp.167.

PROGRAM COST

The FY96 estimated cost for the Studies of Recreationally-Important Fish is $3,000.

Report prepared by: Andrew A. Torres

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 6

PROJECT TITLE: Marine Fish Habitat Improvement and Aggregating Devices (2323)

PERIOD COVERED: October 1, 1995 to September 30, 1996

OBJECTIVE

To enhance access to Guam's heavily-utilized nearshore pelagic fishing grounds through the continued development of a system of fish aggregating devices.

SUMMARY

Installation of fish aggregating devices (FADs) was completed at the twelve sites selected for the Guam FAD program with the installation of the Asiga Point and Fadian Point FADs on May 17, 1996 and the Pati Point ("No.6") FAD on August 12, 1996. Future FAD development activity under Project F-2D-6 will thus be reduced considerably and primarily concentrate on identification and surveys of potential new sites and other miscellaneous program enhancement matters. Figure 1 lists the respective coordinates of the twelve FADs and maps their approximate locations.

The FY95 recommendation to use the Indian Ocean "raft" as an economical, low-resistance and easily maintained alternative buoy system for windward FAD sites was tabled in FY96 and will remain so until the Coast Guard grants an exemption from having to install navigation lights on this particular FAD buoy design. The basis for the exemption request is that the string of purse seine floats forming the raft poses little threat should a vessel collide into such a system. As depicted in Figure 2, the Indian Ocean raft system uses a flag to mark the location of the FAD. Present Coast Guard regulations requiring the installation of a navigation light would necessitate further modification of the raft to include another buoy on the terminal end of the buoy system to support the weight of the navigation light (18.75 lbs.).

FAD maintenance procedures, modifications, recoveries, redeployments, and material procurements in FY96 were conducted under F-2D-12: Maintenance and Redeployment of Fish Aggregating Devices and Shallow Water Moorings. For FY97 and beyond, FAD maintenance and redeployments will be conducted under F-3D-1.

RECOMMENDATIONS

The project to develop and enhance the Guam FAD program under F-2D-6 should be continued with the following recommendations for FY97:

1. Pursue program enhancement activities such as identification and permitting of potential new sites, and production of laminated FAD site maps and route planners for distribution to fishers.

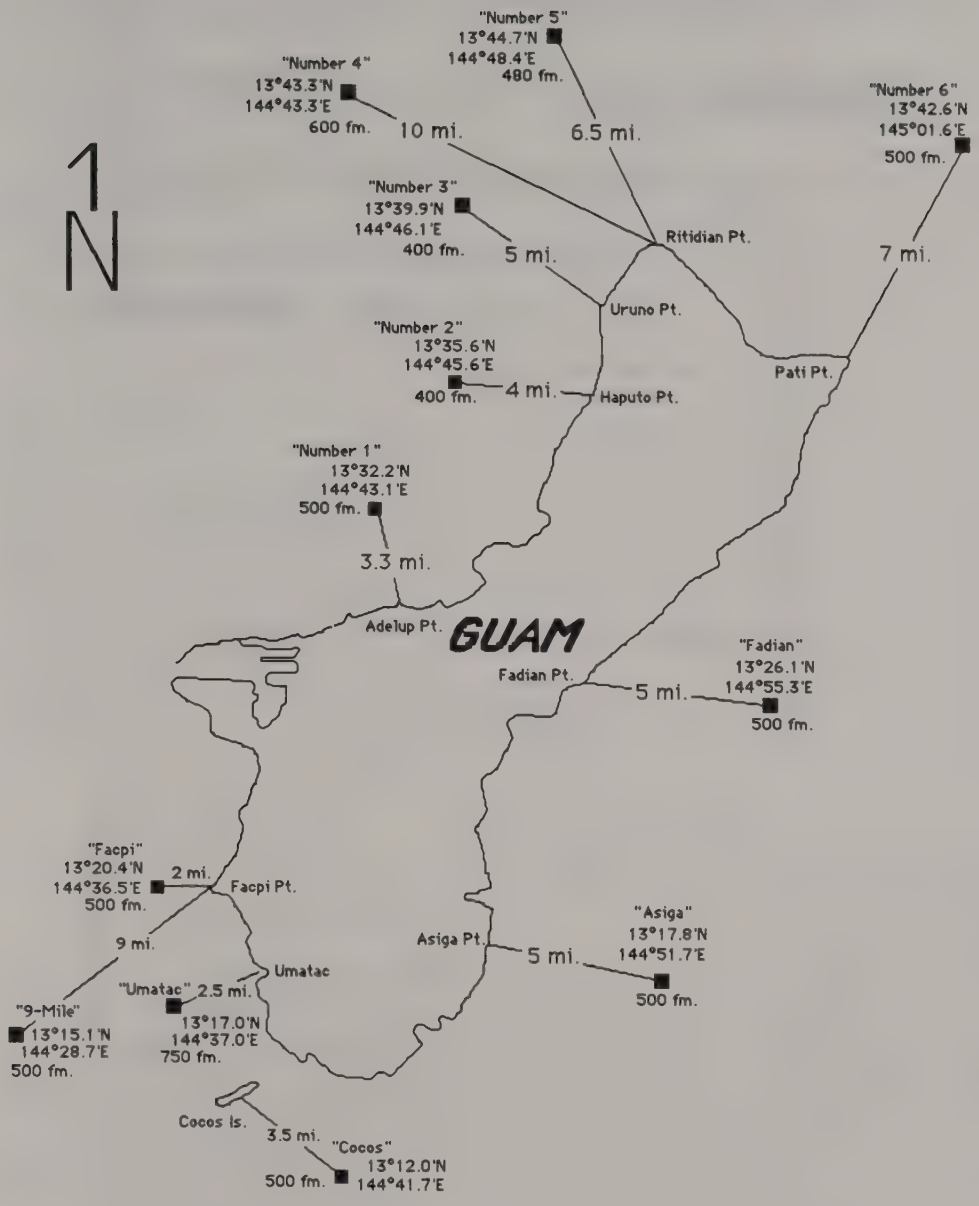


Figure 1. DAWR FAD Sites

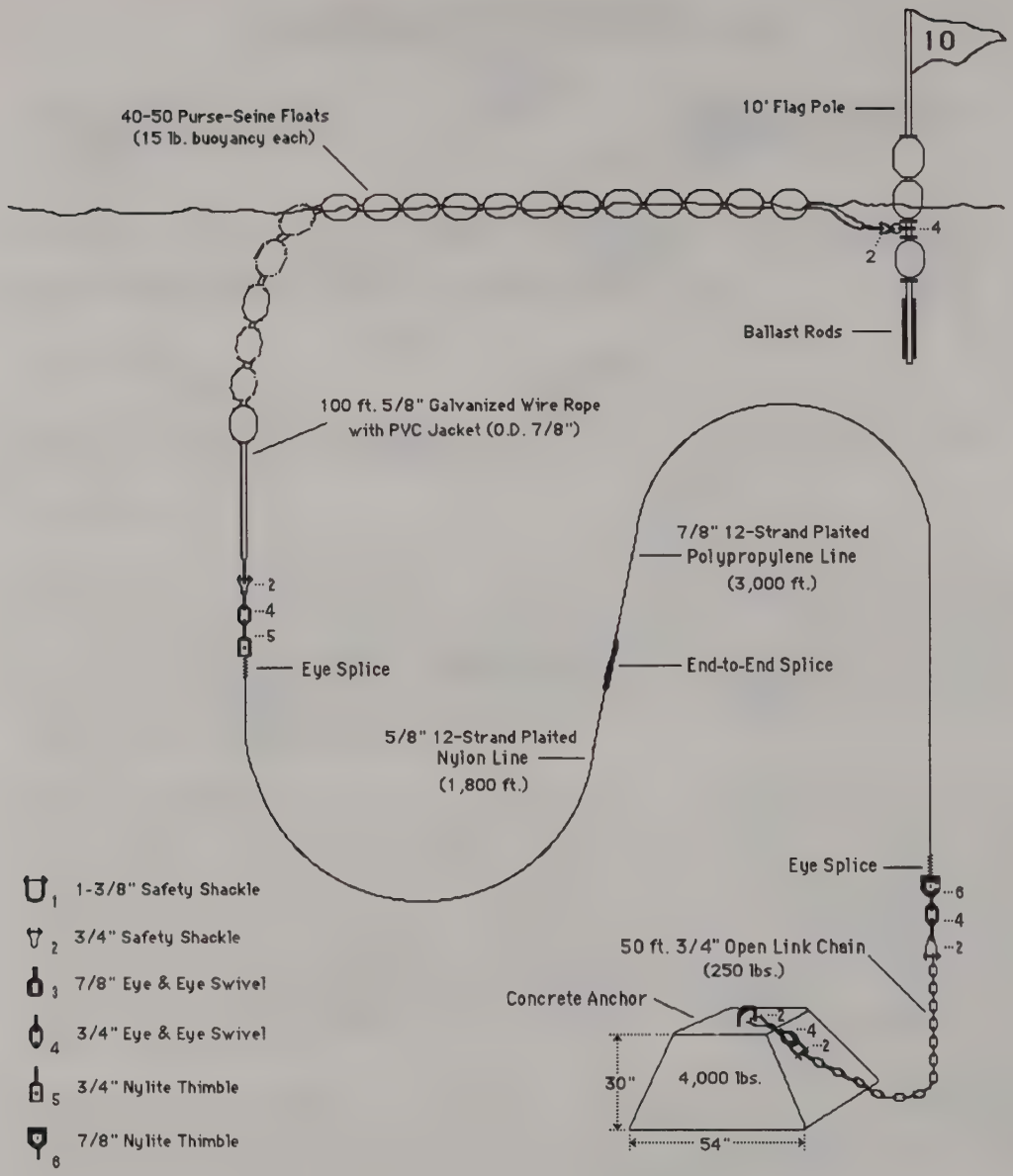


Figure 2. FAD with Indian Ocean Raft Buoy

2. Attach ribbons made of plastic strapping material to upper mooring chain of each FAD to further enhance bait and fish-holding characteristics of the FADs (as recommended in FY95).

3. Obtain exemption from Coast Guard of navigation light requirement for Indian Ocean raft buoy and then begin experimental use of this design at several sites.

PROGRAM COST

The FY96 estimated cost for the FAD project is $114,357.

This report was prepared by: Andrew A.Torres

JOB PROJECT REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 7

JOB TITLE: Merizo Pier and Boat Ramp Facility

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

The Merizo pier and boat ramp facility have been used extensively by the public. The pier has been assessed for various damage due to wear and tear and vandalism since FY94. The original cleats on the pier were determined to be too small, and were replaced with larger cleats. During FY96, proposals for the repair of the Merizo pier and construction of the Merizo boat ramp and parking facility have been forwarded to the Capital Improvement Projects Contract section of the Department of Public Works (DPW) since DPW is the government agency responsible for administering all government construction contracts. Due to the work load of DPW and their prioritization of projects, the Merizo pier and Merizo boat ramp projects were not acted on until 1996. Currently, both projects are pending final approval of engineering plans and specifications at the Department of Public Works, and are awaiting the bidding process. An Environmental Impact Assessment (EIA) was completed for the Inarajan Boat Ramp project. This project is administered by the Department of Public Works.

OBJECTIVES

To redesign and renovate the existing public boat launching ramp and pier located in Merizo.

RESULTS

During FY96, plans to repair the Merizo Pier were forwarded to the Department of Public Works. Public Works has been authorized to utilize some of the funds for this project to expedite putting the project out for bid. Approximately $25,000 has been earmarked to replace and repair the damaged lower and upper rubber bumpers, and to repair and upgrade the lighting and electrical system. Other secondary repairs include repairing damage to the pier ladders, replacing cleats that have been bent, and assessing the upper wooden fenders for future repair. During FY96, the original cleats on the pier were found to be too small for use by boats, and were replaced with larger twelve inch cleats. Twelve inch lag screws used to bolt the pier planks were missing in several areas and were also replaced.

Plans for the repair and reconstruction of a boat ramp and parking facility at Merizo have also been forwarded to the Department of Public Works. DPW is currently coordinating rewriting the specifications and will be advertising the project as a Design and Build project. The project should be put out for bid early in FY97.

Although this project is only expected to report on Merizo fisheries development, work on other development projects has been included as a result of previous program alignment. The construction of a small boat ramp facility at Inarajan Bay is administered by the Department of Public Works (DPW) using funds from the Guam Power Authority. During

FY96, Federal Aid funds were used to conduct terrestrial and marine flora and fauna assessments to complete the EIA for this project. The final EIA has been submitted to DPW. Construction of the ramp was scheduled to begin during FY96, but the project reached a snag since title of several of the properties at the proposed construction site have not been properly secured. The company contracted by DPW to design the facility and undertake the permitting process anticipate resolving this situation during FY97.

The two ramps at the Agana Boat Basin have been assessed for repair work. Numerous vehicles have been observed experiencing problems with traction while retrieving their boats. The Operations Manager of the Port Authority of Guam, the agency responsible for maintenance of the Agana Boat Basin, was contacted during FY96 to discuss using Federal Aid funds to resurface the two ramps. However, according to the Operations Manager, the Port Authority has plans to expand and renovate the Agana Boat Basin in the near future and will be repairing the two ramps with their funding source at that time.

RECOMMENDATIONS

It is recommended that a proposal for conducting secondary repairs on the Merizo Pier be completed during FY97, forwarded to the appropriate agencies for review, and placed out for bid.

PROJECT COST

The cost of the project this fiscal year is $6,331.

This report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 9

JOB TITLE: Development of Inshore Fishing Access Facilities (2331)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

During FY96, an application to construct fourteen fishing platforms around Guam was submitted to the Territorial Seashore Protection Commission of the Department of Land Management. After review and clearance by the Development Review Committee and the required public hearing, it was decided to put the project on hold until the Municipal Planning Councils are contacted and additional public hearings held to address public access and littering concerns.

BACKGROUND

The historical and traditional use along with design, site selection and environmental review for the fishing platform project has been discussed in previous fiscal year reports (Kruckenberg, 1989-1995). There have been no known fishing platforms designed and constructed in the Pacific using pultruded fiberglass members anchored in concrete. This required some extra time and energy to develop the concept. Because inshore fishing continues to be a popular activity, there is a real need to provide greater access to inshore fishing areas and improve safety.

OBJECTIVE

Plan, design and construct inshore fishing access facilities such as reef flat platforms and cliff platforms in the coastal areas of Guam to provide increased safe access to inshore fishing areas.

PROCEDURE

The primary focus for FY96 was the submission of the Territorial Seashore Permit Application to the Department of Land Management. Any additional work is dependent on the approval of this permit.

RESULTS AND DISCUSSION

All site surveys, evaluations, site selections, design plans, and applications to federal agencies have been completed and reported prior to FY96.

An application was submitted to the Territorial Seashore Protection Commission (TSPC) and approved by the Development Review Committee to be placed on the TSPC agenda. In compliance with the TSPC process, a public hearing was held. Members of the public expressed concerns about access across and near private land adjacent to the shoreline and potential littering.

In response to the concerns expressed at the public hearing, it was decided to meet with the Municipal Planning Councils and hold additional hearings in those municipalities with proposed sites. Hopefully this will also encourage and attract fishermen to provide valuable input since the majority of those people who attended the first public hearing were either affected landowners or mayors. The Department has requested TSPC delay placing the project on the agenda until additional public hearings have been completed.

Along with the submission of the Territorial Seashore Permit, a meeting was held at the Department of Public Works to clarify each agencies responsibilities during the bidding process. Pictures were taken at all of the sites during low tide to be used by potential contractors to assess topographic consideration when making a bid.

RECOMMENDATIONS

Despite some opposition during the public hearing, the Division still feels the fishing platform program will improve safety and enhance fishing opportunities. It therefore recommends the fishing platform program continue.

During the public hearing a number of issues surfaced that need direct attention before the program can move forward. These public concerns require the following actions:

1) Obtain Department of Land Management assistance in identifying practical public access to proposed sites through confirmation of ownership and property bounds. Table sites without identifiable public access until platforms at other sites prove effective and the land issues are resolved.

2) Meet with each village Municipal Planning Council with a proposed platform within their jurisdiction to present the plan and receive their input.

3) Hold public hearings in each municipality in coordination with the Department Land Management.

4) Revise the original TSPC application in accordance with the public input addressing all concerns, and resubmit the application to TSPC.

PROGRAM COSTS

The estimated cost of the project was approximately $17,000.

This report was prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 10

JOB TITLE: Masso Reservoir Restoration (2322)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

This project remained inactive during FY96 due to increased effort on other development projects.

BACKGROUND

The project will enhance sportfishing opportunities at Masso Reservoir. The history of the Masso Reservoir Project was outlined in previous job progress reports (Kruckenberg, 1993 - 1995). The project involves dredging of the reservoir, rehabilitation of the water control gate structure, development of the area for public access and the shoreline for fishing. In addition, sediment basins will be constructed in the Masso Valley watersheds.

OBJECTIVES

1. To conduct an assessment of fauna, habitat and facilities on the old Masso Reservoir project site.

2. To utilize the assessment information and review the original project plan to develop a scope of work to restore the Masso Reservoir Project.

RESULTS

A draft conceptual design and scope of work has been prepared for the Masso Reservoir Project. This project remained inactive during FY96 due to increased effort on other development projects.

RECOMMENDATIONS

This program has valuable freshwater fishing potential for Guam while providing a safety factor and enhancing fishing opportunities. It is recommended that this job continue to develop a freshwater reservoir on Guam for sport fishing.

PROGRAM COSTS

The estimated cost of the Masso Reservoir restoration project to date is approximately $1000.

Report prepared by: Wayne Kruckenberg.

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 11

PROJECT TITLE: Fabrication and Deployment of Shallow Water Moorings (2323)

PERIOD COVERED: October 1, 1995 to September 30, 1996

OBJECTIVE

To develop a shallow water mooring program at popular fishing and recreational diving locations to minimize anchor damage to reef habitats.

SUMMARY

Figure 1 provides a list of the thirty-two shallow water mooring (SWM) sites that have been proposed by DAWR to date, and a map of their approximate locations. Additional sites may be included at a later date based on demand and discovery. Conversely, sites may be deleted if they are found to be in areas unsuitable for fishing or diving, or are in conflict with local, federal or military regulations.

Vessel size limits for the proposed SWMs have not yet been established, but are expected to be in the 5 to 10-ton range. Figure 2 illustrates the design of the SWM systems and their components. The smaller, more economical Type I buoy design will be used for most outer-harbor sites because of its ability to withstand rough seas and typhoon conditions. The Type II buoy design on the other hand, places much more strain on the mooring system in rough conditions and thus may be reserved for use in Apra Harbor only. The type of anchoring system used for either type of buoy will be determined by the type of substrate at the selected anchor site: a cemented eye bolt for uneven rocky substrate, or a one-ton pyramid-shaped concrete anchor for flat sandy sites.

For sites where the anchor is set in depths less than ten fathoms (60 feet), approval must also be obtained from the Territorial Seashore Protection Commission (TSPC). The process includes a public hearing which may take an additional month or two to complete.

RECOMMENDATIONS

Inspection dives are planned during the first half of FY97 at each of the proposed sites to survey and select anchor locations. Once the site surveys are completed and the site map finalized, a permit application for the SWM project will be submitted to the Army Corps of Engineers (ACOE) for approval. Copies of the application will concurrently be submitted to the Bureau of Planning's (BOP) Coastal Zone Management (CZM) program, the Guam Environmental Protection Agency (GEPA), the Department of Parks and Recreation's (DPR) Historic Preservation Office (HPO), the Port Authority's Harbormaster of Guam, the Staff Civil Engineers of U.S. Naval Activities (inner- and outer-Apra Harbor sites) and NCTAMS (Double Reef, Haputo Beach, NCS Beach sites) and the Naval Activity Port Services Officer. Presuming that there are no complications or objections by ACOE, BOP-CZM, GEPA, DPR-HPO, the Harbormaster, the Navy or any other interested parties, final

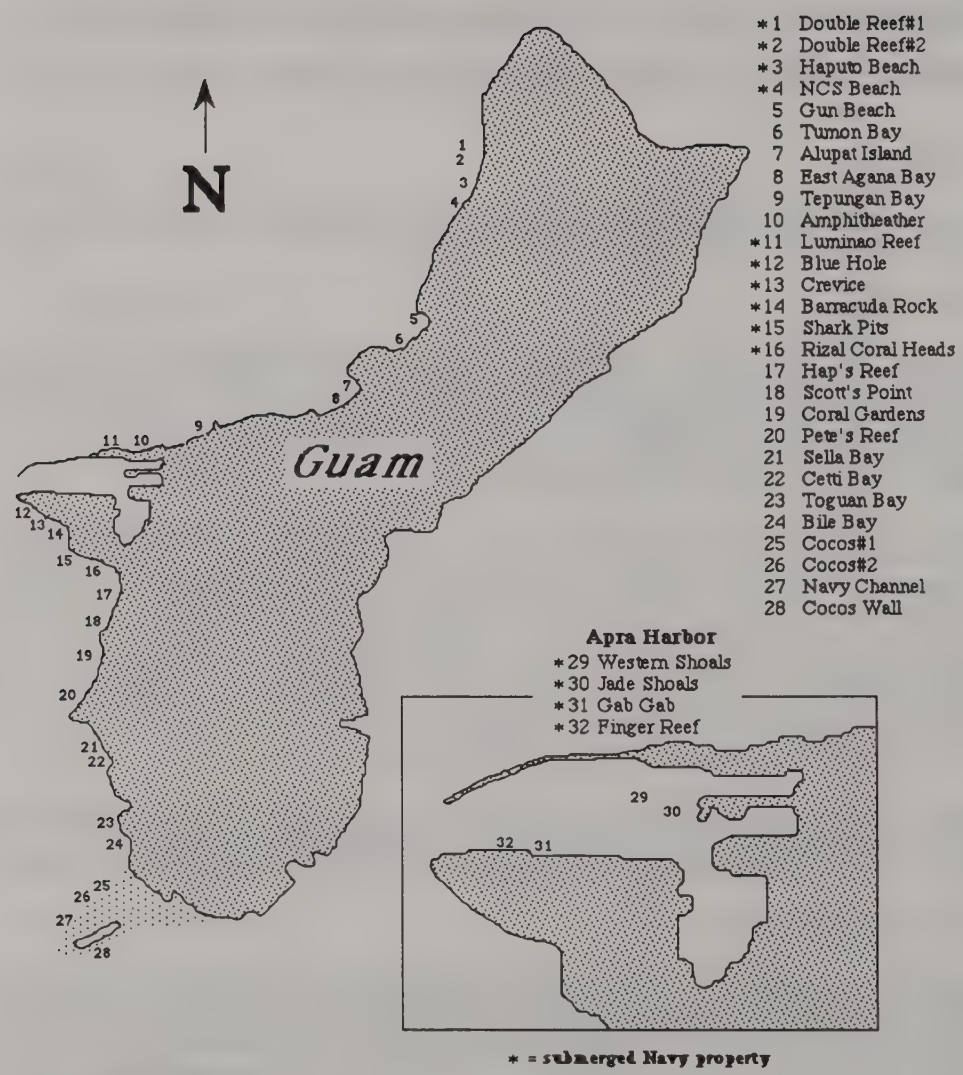


Figure 1. Shallow Water Mooring Sites

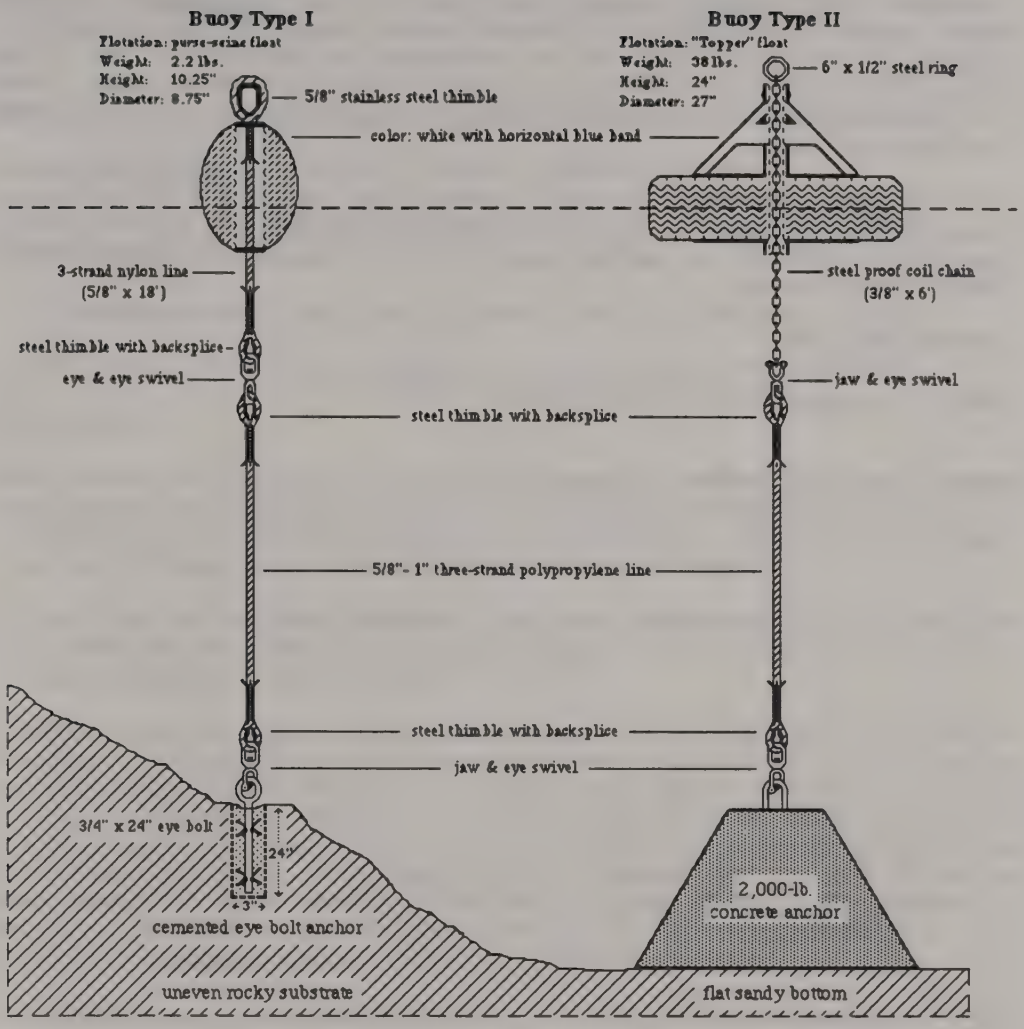


Figure 2. Shallow Water Mooring Designs

ACOE approval is expected in approximately 2-3 months after the permit application is submitted.

Although most of the initial activity for the SWM project in early FY97 will involve conducting site surveys and obtaining authorization from the appropriate Naval, local and federal agencies, a similar measure of effort will also be allocated for the procurement of materials and services necessary for the construction and installation of the SWMs. Included in this effort will be the acquisition of concrete anchors, purchase of ropes, chains and miscellaneous hardware and identification of qualified vendors to conduct actual installation procedures.

To avoid possible confusion in the future annual reports, activity in FY97 and beyond concerning the development of the SWM program will be disassociated from F-2-D-6 and instead be conducted in its entirety under F-2-D-11: Fabrication and Deployment of Shallow Water Moorings.

PROGRAM COST

The FY96 estimated cost for the SWM project is $3,509.

Report prepared by: Andrew A. Torres

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 12

PROJECT TITLE: Maintenance and Redeployment of FADs and SWMs (2323)

PERIOD COVERED: October 1, 1995 to September 30, 1996

OBJECTIVES

1. To maintain, preserve and efficiently replace Guam's fish aggregating devices.

2. To maintain, preserve and efficiently replace Guam's shallow water moorings.

SUMMARY

FAD maintenance procedures, modifications, recoveries, redeployments, and material procurements for FY96 were conducted under F-2-D-12: Maintenance and Redeployment of Fish Aggregating Devices and Shallow Water Moorings. For FY97 and beyond, however, FAD maintenance and redeployments will be conducted under F-3-D-1.

Figure 1 lists the respective coordinates of the twelve operational FADs and maps their approximate locations. Figure 2 diagrams the design and construction of the FAD system presently being used at each of the sites.

Five FADs came off station in FY96, with the Cocos site accounting for two of the five FAD losses. Of the five losses, two buoys were eventually recovered. Each had broken off at a depth of approximately 250 feet. Interestingly, the Haputo FAD recovered on 11/24/94 had broken off at about the same depth as well. Considering that these breaks did not occur in either the upper- or lower-mooring hardware, or at any of the splices, the likely causes for failure of the recovered systems is narrowed down to either fish-bite or hook damage. The unrecovered Cocos FAD lost in February of 1996 on the other hand, is most likely attributable to the age of the system given that it remained on station in a windward and relatively high-current site for over thirty-eight months.

The average time on station for the FADs for FY96 was 13 months; roughly a 5-month decrease from the FY95 average of just over 18 months. The recent expansion of the FAD program in the last year and a half from four to twelve sites best accounts for the decline because the short period of time that each of the eight recently-deployed buoys have been on station was included in calculating the FY96 average time on station.

The average cost per FAD system installation in FY96 was $9,957 (Table 1), a 17% increase from the FY95 average cost per installation. The increase was due in large part to additional services requested for the transport and preparation of FAD buoys, and several extended deployment trips to accommodate the changing of navigation lights of operational FADs on the return trip. Table 2 lists the sites and dates of FY96 deployments and provides a cost breakdown for both buoy preparation and deployment procedures.

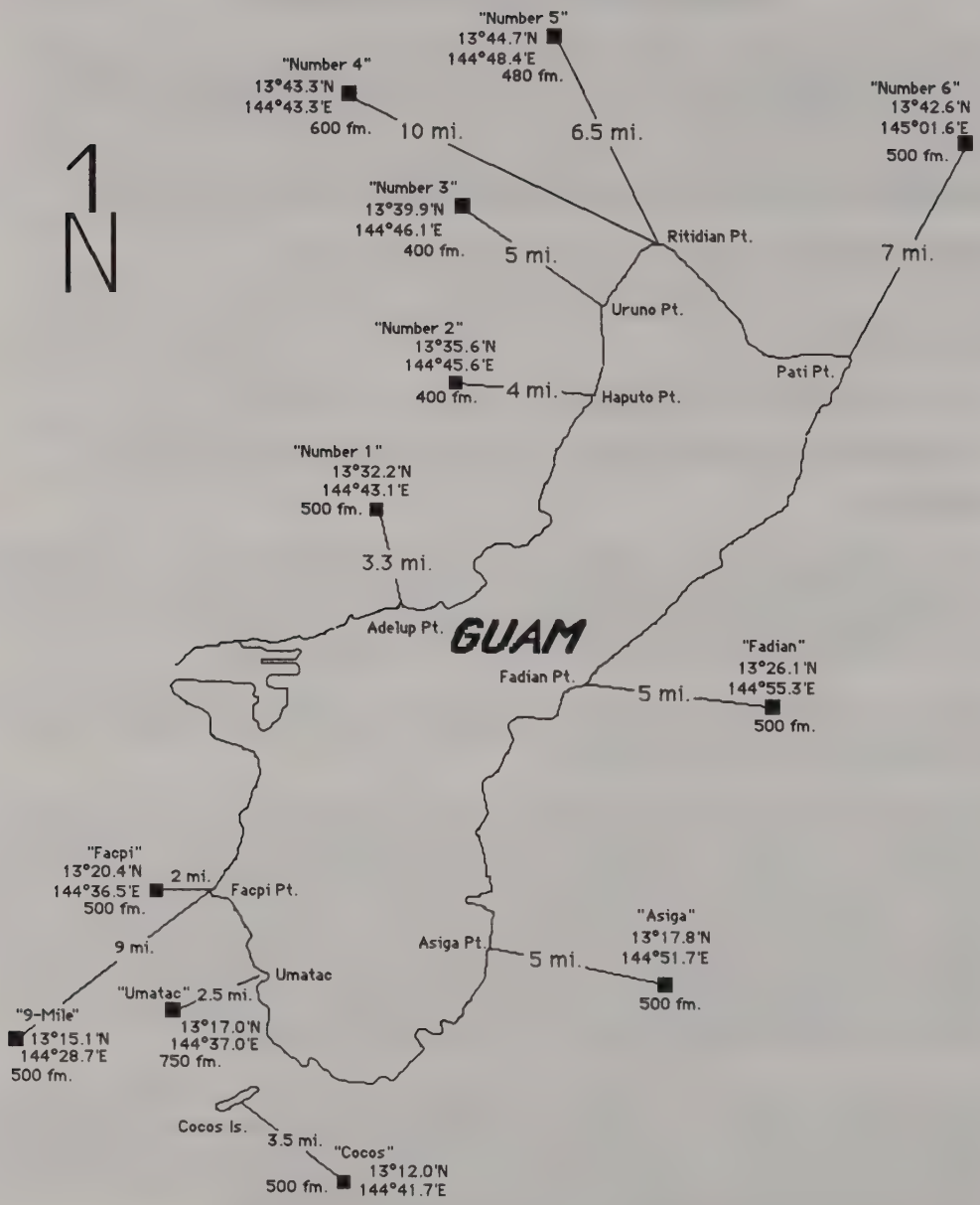


Figure 1. DAWR FAD Sites

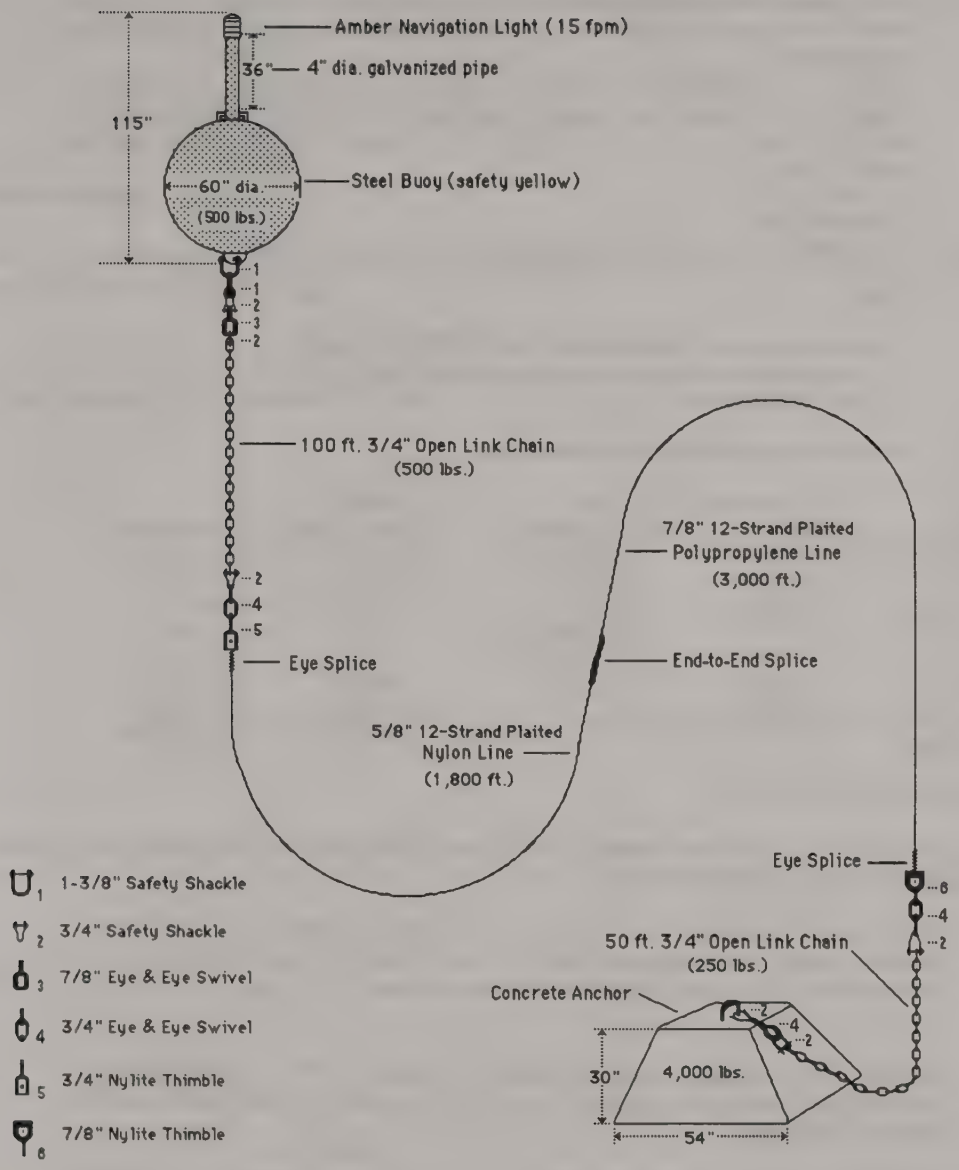


Figure 2. FAD with Spherical Steel Buoy

Table 1. FY96 Average Cost per FAD System.

Item/Service	Cost
Buoy	$ 518.50
Buoy Preparation*	$ 481.57
Anchor Block	$1,025.00
Mooring System	$4,854.00
Navigation Light	$ 242.93
Deployment**	$2,835.16
Total:	**$9,957.16**

*Includes transport of FAD materials from DAWR down to port.
**Includes extended voyages to change navigation lights on return trip from several deployments.

Table 2. FY96 Buoy Preparation and Deployment Costs.

FAD Site	Deployment Date	Type of Deployment	COSTS Buoy Prep.	Deployment
Adelup ("No.1")	1/11/96	replacement	$279.00	$2,311.50
Umatac	1/26/96	replacement	$668.50	$2,630.05
Cocos (a)	2/13/96	replacement	$774.50	$3,441.19
Asiga	5/17/96	new (w/Fadian)	$151.00	$2,363.22
Fadian	5/17/96	new (w/Asiga)	$151.00	$2,363.22
Cocos (b)	7/24/96	replacement	$906.00	$3,005.00
Pati ("No.6")	8/12/96	new	$441.00	$3,731.93
Average:			**$481.57**	**$2,835.16**

RECOMMENDATION

The project to maintain and reinstall FADs and SWMs should be continued with the following recommendations for FY97:

1. Reestablish the open account to prepare FAD systems for deployment, conduct actual deployments, recover errant buoys, and perform on-site replacement of expired navigation lights and worn FAD buoys on an as-is-needed basis.

2. Identify and contract a private vendor to conduct SWM maintenance and reinstallation services on a short notice and as-is-needed basis similar to that of the FAD project.

3. Reorder ropes, chains and other miscellaneous mooring hardware to establish an inventory sufficient to replace up to ten 500-fathom FAD systems and twenty 10-fathom SWM systems.

4. Execute another work order (or memorandum of understanding) with the Construction Trades Program of JFK High School to construct and deliver 20 additional 2-ton pyramid-shaped concrete FAD anchors since only one remains in inventory; and 10 similarly-shaped 1-ton concrete anchors for use with the SWM project.

5. Repair the Division's existing work-boat to allow for some minor maintenance routines to be conducted until the arrival of the new work vessel.

6. Establish and maintain an inventory of other miscellaneous equipment, supplies and materials, such as navigation lights and batteries, necessary for both the FAD and SWM projects.

PROGRAM COST

The FY96 estimated cost for the project to continue maintenance and reinstallation of FADs and SWMs is $27,854.

Report prepared by: Andrew A. Torres

JOB PROJECT REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 13

JOB TITLE: Ylig Boat Ramp

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Plans to construct small boat ramp facilities on the east side of Guam have been ongoing. The south side of Ylig River is currently used as a makeshift ramp and is considered a potential site for the construction a boat ramp. However, owners of the property on the north side of Ylig River have also been approached to determine the feasibility of pursuing the construction of a boat ramp facility. The north side of Ylig is preferred due to potential traffic problems with access into the south side of Ylig.

OBJECTIVE

To provide boating and fishing access on the east side of Guam at the Ylig River.

RESULTS

The southern side of Ylig River has previously been identified as a potential boat ramp site because of its historical use as a makeshift ramp. Owners of the property have been approached with conceptual plans to determine if it would be feasible to pursue obtaining some of their property to construct a boat ramp and parking facility. However, concerns with traffic access into and out of this site make this site less desirable.

During FY96, the north side of the river has been identified as a more desirable site since access into the site by vehicle-trailers will be safer. Stands of *Nypa fruticans* are also less prevalent along the bank of the northern side of the river. This property is currently owned by Beyond Tumon Development Corporation, with Triple J Enterprises as the on-island representative of this corporation. A representative of Triple J was approached during FY96 to discuss the feasibility of pursuing obtaining a portion of their property adjacent to Ylig River for a boating ramp and parking facility. However, the property, Lot 165-1, is currently in litigation between Beyond Tumon Development Corporation and an heir of the former landowner. The Triple J Enterprises representative recommended that they be contacted during early FY97 to follow-up on the status of the litigation case. Any negotiating with Beyond Tumon Development Corporation for a boat access facility cannot be pursued until the land issue is settled.

RECOMMENDATIONS

It is recommended that the owners of the property on the north side be periodically contacted during FY97 to determine if pursuing this site is feasible. It may be necessary to forgo pursuing the northern site and reestablish contact with the owners of the southern site during FY97 to complete this project.

PROJECT COST: The cost of the project this fiscal year is $1,550.

This report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

JOB TITLE: Giant Clam Transplantation

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Mature giant clams (*Tridacna derasa*) transplanted to sites in Sasa Bay (site B) and Jade Shoals (sites C and D) during FY89 are monitored and measured at least once a year (Figure 1). Mature giant clams were also transplanted to the Glass Breakwater (sites E and F) during FY90, but were all poached by mid-June 1990. Of the 100 five-year old clams transplanted in FY89, only 20 remain, three less than last year. Two clams were missing and assumed to be poached, while one had expired. The shell from the expired clam was brought to the Department of Agriculture's Division of Aquatic and Wildlife Resources. The remaining clams were measured and checked for signs of parasitism, predation, or poaching on June 6, 1996. The remaining clams are all located at a depth of 10 meters.

OBJECTIVES

To reestablish a larger variety of giant clam on the reefs of Guam.

PROCEDURES

The procedure for site selection, processing, field placement, and monitoring were reported in FY89. Annual visits are made to monitor and measure the clams. Clams that were located at inner Sasa Bay (site A) and relocated to site B have been recorded as site B1. The status of the clams regarding growth, predation, depth, and general health has been recorded and reported annually. The remaining clams are located at three sites in Apra Harbor.

RESULTS

During FY96, all clams experienced positive growth. Since FY95, two clams were missing and assumed poached and one clam had expired, all at sites B/B1. Since FY95, the clams at site B1 experienced the greatest average growth, mean daily growth rate, and annual growth rate (Table 1).

Table 1: Growth (mm) of transplanted *Tridacna derasa* between April 10, 1995 and June 6, 1996. B1 represents the transplanted clams from site A to site B. † Since last measured.

Site	# Clams	# Days†	Growth Range	Average Growth	Mean Daily Growth Rate	Annual Growth Rate
B1	4	422	4-77	31	0.073	26.81
B	6	422	2-71	18.7	0.044	16.15
C	5	422	1-14	7.2	0.017	6.23
D	5	422	2-17	12	0.028	10.40

Relocating them to site B from site A resulted in a fourfold increase in their annual growth rate compared from FY95 (6.57 to 26.81). The average growth of the clams from FY95 in site B1 was 31 mm, while sites B, C, and D had an average growth of 18.7 mm, 7.2 mm, and 12 mm respectively (Table 2).

Table 2: Total Growth Rate of surviving transplanted *Tridacna derasa* between September 20, 1989 or September 28, 1989 and June 6, 1996. B1 represents the transplanted clams from site A to site B.

Site	# Clams	Mean Total Growth	Mean Daily Growth Rate	Mean Yearly Growth Rate
B1	4	64.80	0.03	9.64
B	6	120.50	0.07	17.93
C	5	140.20	0.06	20.93
D	5	142.00	0.06	21.20

Overall, the clams at sites C and D have had the highest overall Mean Total Growth, Mean Daily Growth Rate, and Annual Growth Rate.

There is a significant difference in the Mean Daily Growth Rates and the Adjusted Annual Growth Rates between the clams at site A and sites B, C, and D. However, these values are similar between the clams at sites B, C, and D (Table 2). The clams at site A had a Mean Daily Growth Rates of 0.002, while sites B, C, and D had Mean Daily Growth Rates ranging from 0.020 to 0.030. The clams at site A had an Adjusted Annual Growth Rate of 8.49, while the clams at sites B, C, and D had Adjusted Annual Growth Rates ranging from 23.46 to 24.19.

Summaries are listed on the growth of the surviving clams at all four sites from initial transplantation (Table 3). All the remaining clams are presently at a depth of ten meters. The clams at sites B, C, and D show similar Mean Total Growth, Mean Daily Growth Rates, and Mean Yearly Growth Rates. The clams at site A had a Mean Total Growth, Mean Daily Growth Rates, and Mean Yearly Growth Rates approximately a third that of sites B, C, and D, probably due to lower photosynthetic activity from higher silt levels in the water. The clams at site A were moved to site B and will be measured during FY96 to observe if an increase in growth rate occurred.

Table 3: Annual Growth Rates of *Tridacna derasa* since transplanting on September 1989. Annual Growth Rate, millimeters per year, shown is calculated only for the period between measurements.

	AGE (years)					
SITE	1.35	2.07	3.18	4.96	5.56	6.72
A (shallow)	19.57	9.8†				
B1 (A deep)	17.84			5.4††	6.57	26.81
B (shallow)	27.51†					
B (deep)	39.15	26.24	21.85	21.52	8.02	16.15
C	37.41	25.61	49.31	5.25	7.56	6.23
D	45.22	24.42	41.01	4.23	10.9	10.38

†Measurements for sites A (shallow) and B (shallow) ended, since clams were poached.

††Measurement for site B1, formerly A (deep), were not available for 2.07 and 3.18 yrs, since they could not be located. 5.4 is average growth rate between 1.35 yr and 4.96 yr.

RECOMMENDATIONS

It is recommended that this project remain active as long as the transplanted clams are living. Since most of the clams from the initial transplanting have been poached, it is not recommended to obtain new clams until a more suitable area for seeding or a marine preserve with adequate enforcement is established. During FY96, the remaining sites should be photographically mapped and their location drawn in detail to facilitate identification of individual clams and enable finding the sites easier.

Report prepared by: Thomas Flores, Jr.

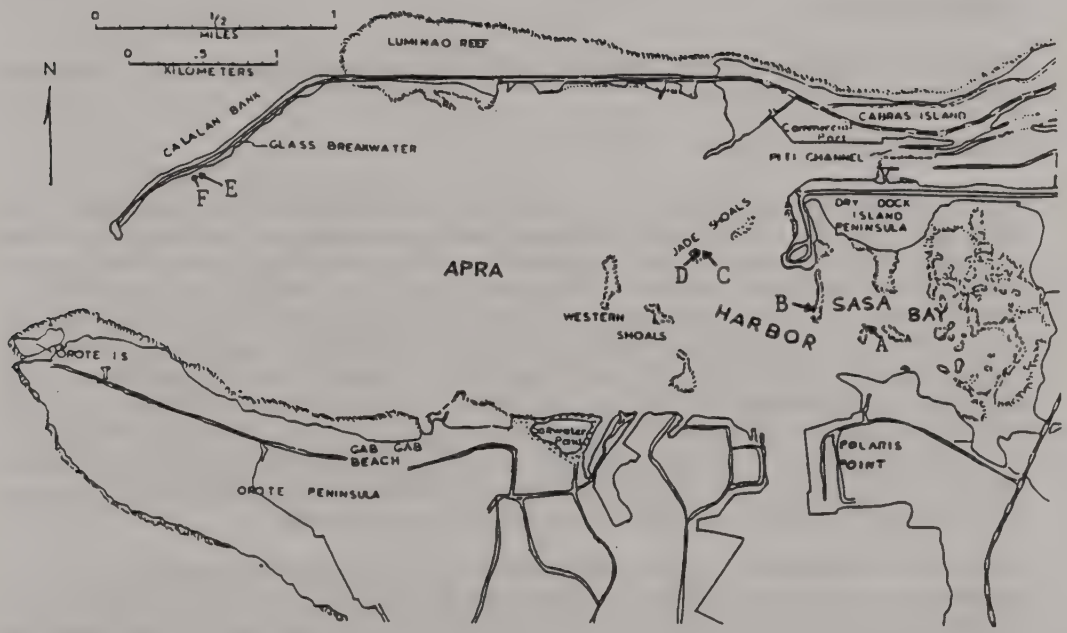


Figure 1. Map of Apra Harbor showing locations of transplanted Tridacna derasa. Twelve giant clams, 6 each at 5 and 10 meters respectively, were transplanted at each site.

GUAM COMMERCIAL FISHERIES

STATE: Territory of Guam

JOB TITLE: Commercial Fisheries on Guam

PERIOD COVERED: October 1, 1995 to September 30, 1996

BACKGROUND

The commercial fisheries program was established in 1979 to learn more about the fishery resource being caught and sold on Guam. The program was initiated by the National Marine Fisheries Service (NMFS). Initially, data was only collected from the Guam Fishermen's Cooperative in Agana. The program has slowly grown over time with many of the initial participants no longer in business. As part of the long-term program plan, data collection and management has shifted from NMFS in Hawaii to the Guam Division of Aquatic and Wildlife Resources. Program responsibility has slowly increased to the point where we now handle the entire program.

OBJECTIVES

To monitor, analyze and report on locally caught fish sales and related activities through the collection of vendor receipts.

PROCEDURES

The Guam Commercial Fisheries receipt books are provided to each volunteer vendor in the program. While the catch is being purchased, each cooperating vendor is asked to record the following information into the assigned block on each receipt: name of the person providing the catch, date, number of fishermen, hours fished, fishing location and fishing method. Listing of the fishing location numbers and fishing method codes are provided on the inside of each receipt book cover. The catch information is broken down into six primary areas: (1) Bottom fish, (2) Reef fish, (3) Troll (pelagic) fish, (4) invertebrates, (5) Seaweed and (6) Imported Items. A code number is assigned to each category. Space is provided to indicate the number of items, total weight, price paid per pound, the value of the items, the total value of the transaction and any additional remarks. There are three copies of each receipt with one for the person representing the catch, one for the vendor and one for processing the information into the computer database.

Vendors are visited on a regular basis to monitor the completion of the forms, collect completed receipt books, to check on errors in the data and insure that they had a supply of receipt books. A logbook is used to record when a receipt book was initially given and received back from a vendor. Although there is a category for imported fish, this program intends to monitor locally caught and sold fish.

RESULTS

At this time, the cooperators with the commercial fisheries program are voluntary. Based on our observation of commercial sales, we cover an estimated 75% of the total coverage of locally caught fish. The percentage has increased because the coverage by the program has

grown. There are presently 12 fish vendors that use the receipt books in their business operations.

RECOMMENDATION

A law or regulation be passed that would require that people use an identification number in selling their catch to vendors and for vendors of local fish products to use our commercial fisheries receipts in their business transactions. This would give a more comprehensive view of the commercial fishery activity around Guam.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUBPROJECT NO: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer (1430, 1460)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Official logs with deer harvest statistics for Andersen Air Force Base (AAFB) were examined and revealed a total of 4,393 hunter sorties, a harvest of 111 deer, and a harvest rate of one deer per 18.7 hunter-days. On Naval Computer and Telecommunications Area Master Station (NCTAMS), there were 1,190 hunter sorties, a take of 13 deer, and a harvest rate of one deer per 42.3 hunter-days. Twenty-nine deer were taken during a special hunt on AAFB during July and August. Population trend data obtained with spotlight counts on AAFB and Naval Ordnance Annex (formerly Naval Magazine) showed no significant changes ($P > 0.10$) in deer numbers, with averages of 7.6 and 3.0 animals recorded per km, respectively, during counts. Efforts to revise Guam's existing deer hunting regulations are underway in an attempt to liberalize restrictions on the take this species. Counts of feral water buffalo at Ordnance Annex showed a significant increase ($P = 0.005$) to an all-time high of 2.8 animals per km during FY96.

BACKGROUND

The Guam deer (*Cervus mariannus*), or Philippine sambar deer, has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) since 1961 (DAWR 1961-1995). Preliminary information on distribution, population trends, and biology appeared in Wheeler (1979). Deer hunting statistics have been compiled annually since 1968. Currently, Guam has a split deer hunting season, with the first segment running from October 1 to December 31 and the second from September 1-30. There is a bag limit of one antlered deer per season per license holder exclusive of any special harvest.

OBJECTIVES

To determine the current size and distribution of the deer population on Guam and to monitor population trends.

PROCEDURES

1. Conduct monthly spotlight counts on AAFB and Ordnance Annex, and periodic counts elsewhere on the island.

    a. Record number, sex, age, and group composition.

b. Analyze count data and compare with previous data to discern population trends.

2. Monitor hunter participation and harvest during the legal hunting season.

3. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

Hunter questionnaires were discontinued this year because of a lack of manpower and low return rates in previous years, which may have resulted in biased sampling of the hunter community. The use of questionnaires as a management tool by the DAWR may be reinstituted in the future once a game biologist is hired.

Records of hunting activity and harvest were kept by officials at AAFB and NCTAMS during the deer hunting season (Table 1). According to hunter logs from AAFB, 1,269 hunter-days (2,488 sorties; gun hunting only) were expended at Northwest Field (NWF) and resulted in the harvest of 80 deer. At Andersen South, 21.6 hunter-days (69 sorties; bow hunting only) were registered, with no deer taken. Hunting areas on the main portion of the base (Tarague basin, near the landfill, and areas north and east of the flightline) recorded 787.7 hunter-days (1,836 sorties; primarily bow hunting), with 31 deer harvested.

Table 1. Hunter effort and deer taken on AAFB and NCTAMS during FY96, based on official hunter logs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul[1]	Aug[1]	Sep	Total
Andersen Air Force Base													
Northwest Field (gun hunting only)													
No. hunter sorties	687	648	580							6	1	566	2,488
No. hunter days (8 hr)	344.2	320.3	309.4							3	0.5	291.6	1269.0
Deer taken	21	19	14							0	1	25	80
Days effort/take	16.4	16.9	22.1							-	0.5	11.7	15.9
Main Base (primarily bow hunting, except during the special hunt in July-August)													
No. hunter sorties	402	198	119							482	503	132	1,836
No. hunter days (8 hr)	164.8	61.8	44.3							217.7	253.4	45.7	787.7
Deer taken	2	1	0							13	15	0	31
Days effort/take	82.4	61.8	-							16.7	16.9	-	25.4
Andersen South (bow hunting only)													
No. hunter sorties	34	24	11									0	69
No. hunter days (8 hr)	12.3	5.9	3.4									0	21.6
Deer taken	0	0	0									0	0
Days effort/take	-	-	-									-	-
NCTAMS (gun and bow hunting)													
No. hunter sorties	303	306	372									209	1,190
No. hunter days (8 hr)	137.5	140.0	170.4									101.6	549.5
Deer taken	2	3	3									5	13
Days effort/take	68.8	46.7	56.8									20.3	42.3

[1]results from the special hunt.

This last data category includes the results of a special hunt held in July and August for areas on the main base (although one handicapped hunter was allowed to hunt in NWF), which resulted in a kill of 29 deer (15 females, 14 males; 23 killed by shotgun, 6 by bow). The Conventional Weapons Storage Area was not open to hunting this year. At NCTAMS, 549.5 hunter-days (1,190 sorties; gun and bow hunting) were expended, with 13 deer killed.

Spotlight Count Trends

On AAFB, deer numbers observed throughout the year did not vary statistically from those of the previous year (Mann Whitney *U*-Test, $U' = 96$, $n_1 = 16$, $n_2 = 10$, $P > 0.10$). The average number of deer seen per count decreased slightly from 62.7 (9.0 deer/km) in FY95 to 58.7 (7.6 deer/km) in FY96 (Table 2). The largest single nightly count on AAFB decreased from 97 (15.2 deer/km) in FY95 to 91 (11.4 deer/km) in FY96.

Table 2. Composition of deer seen during spotlight counts on AAFB, FY96.

	----- 1995 -----			---------- 1996 ----------											
Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Mean	SD
Unclassed buck	2	2	2	1	3	5	3		2		5	1	26	2.6	1.4
Spike	2	1	6	5	7	9	5		1		2	1	39	3.9	2.
2 pt	0	3	0	8	2	8	1		4		4	1	31	3.1	3.0
3 pt	0	2	6	4	4	1	5		6		6	2	36	3.6	2.2
4 pt	1	0	1	3	1	3	0		1		2	0	12	1.2	1.1
Doe	16	13	18	16	40	19	34		37		27	18	238	23.8	9.9
Yearling	5	0	3	6	9	5	7		3		6	3	47	4.7	2.5
Fawn	2	4	3	4	5	2	0		3		3	1	27	2.7	1.5
Unclassed deer	10	15	13	13	20	15	15		9		12	9	131	13.1	3.4
Total deer	38	40	52	60	91	67	70	nc	66	nc	67	36	587	58.7	17.3
Miles traveled	5	5	5	5	5	5	4		5		4	5	48	4.8	0.4
Km traveled	8	8	8	8	8	8	6.4		8		6.4	8	76.8	7.7	0.7
Deer/mi	7.6	8.0	10.4	12.0	18.2	13.4	17.5		13.2		16.8	7.2	124.3	12.2	4.1
Deer/km	4.8	5.0	6.5	7.5	11.4	8.4	10.9		8.3		10.5	4.5	77.8	7.6	2.6

nc = no count was made.

On Ordnance Annex, deer numbers showed a non-significant decrease (Mann Whitney *U*-Test, $U' = 41.5$, $n_1 = 9$, $n_2 = 7$, $P > 0.10$) in FY96 from FY95 (Table 3). The average number of deer recorded per count fell from 72.7 (3.2 deer/km) animals in FY95 to 67.1 (3.0 deer/km) animals in FY96 (Table 3). Despite this, the largest single nightly count increased from 85 deer in FY95 to 88 deer in FY96.

Other Activities

As a follow-up to Wheeler's (1979) report on Guam's deer, work began in FY95 on a new publication to update readers on recent population trends and hunter harvests, general biology, and ecological impacts, as well as needed management actions. No progress was made this year in completing the report, but writing will resume in FY97.

RECOMMENDATIONS

Continue spotlight counts at present intensity on AAFB and Ordnance Annex. Collect biological data from carcasses whenever possible. A study to examine the impacts of deer on native ecosystems remains a high priority.

Table 3. Composition of deer seen during spotlight counts an Ordnance Annex, FY96.

	----- 1995 -----			---------- 1996 ----------											
Class	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Mean	SD
Unclassed buck	1	4	3	0	1	2	3	5				4	23	2.6	1.7
Spike	2	2	1	5	3	16	8	2				0	39	4.3	5.0
2 pt	1	1	1	4	0	3	3	1				2	16	1.8	1.3
3 pt	2	5	4	2	2	5	0	4				1	23	2.8	1.8
4 pt	1	0	1	3	0	0	1	1				0	7	0.8	1.0
Doe	34	29	37	29	32	28	28	35				37	289	32.1	3.8
Yearling	10	4	4	3	4	7	8	5				4	49	5.4	2.4
Fawn	2	2	1	6	4	3	2	4				1	25	2.8	1.6
Unclassed deer	12	18	8	19	6	24	25	9				10	131	14.6	7.1
Total deer	65	65	60	71	52	88	78	66	nc	nc	nc	59	604	67.1	10.8
Miles traveled	14	14	14.2	14	14	14	14	14				14	126.2	14.0	0.1
Km traveled	22.5	22.5	22.9	22.5	22.5	22.5	22.5	22.5				22.5	203.1	22.6	0.1
Deer/mi	4.6	4.6	4.2	5.1	3.7	6.3	5.6	4.7				4.2	43.1	4.8	0.8
Deer/km	2.9	2.9	2.6	3.2	2.3	3.9	3.5	2.9				2.6	26.8	3.0	0.5

nc = no count was made.

PROGRAM COST

The estimated cost of the deer population and distribution project under W-1R-4 is $40,231.

LITERATURE CITED

Division of Aquatic and Wildlife Resources. 1961-1995. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.

Wheeler, M. E. 1979. The biology of the Guam deer. Div. Aquatic Wildl. Resources Tech. Rept. No. 3, Mangilao, Guam. 53 pp.

This report was prepared by: Gary J. Wiles and Benedict Reyes

APPENDIX 1

The Population Size and Distribution of Wild Asiatic Water Buffalo on Guam

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

The abundance of wild (feral) Asiatic water buffalo (*Bubalus bubalis*) on Naval Ordnance Annex (formerly Naval Magazine) showed a significant increase to an all-time high of 2.8 animals/km in FY96. The buffalo population on the base has displayed an overall increasing trend since the late 1970s.

RESULTS

Spotlight counts of Asiatic water buffalo, known locally as carabao, on the U.S. Naval Ordnance Annex were initiated in 1966 by the Division of Aquatic and Wildlife Resources (DAWR). Survey methodology is the same as for deer counts (Project No. W-1R-4, Subproject No. W-1, Study No. 1, Job No. 1). Only nine counts were made on the Annex in FY96. The average number of water buffalo seen per count showed a significant increase from 1.8 animals/km in FY95 to an all-time high of 2.8 animals/km in FY96 (Mann-Whitney *U*-Test, $U=7$, $P = 0.005$) (Table 1). A mean of 62.8 animals was seen per count this year. The largest number of water buffalo recorded on a monthly count increased from 74 animals in FY95 to 86 animals in FY96. No additional work to assess population parameters of the Ordnance Annex herd was done during the year because of limitations in manpower.

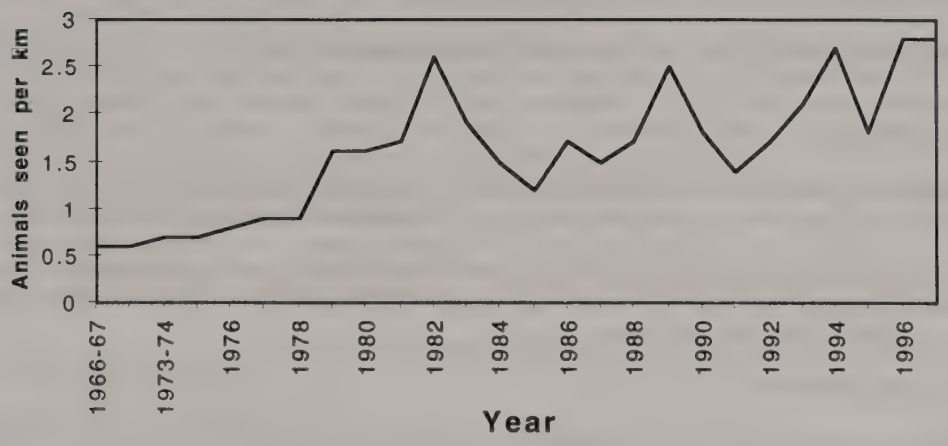
Table 1. Results of monthly spotlight counts of feral water buffalo at Ordnance Annex, FY96.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	86	22.5	3.8	14	6.1
Nov	54	22.5	2.4	14	3.9
Dec	70	22.9	3.1	14.2	4.9
Jan	54	22.5	2.4	14	3.9
Feb	65	22.5	2.9	14	4.6
Mar	51	22.5	2.3	14	3.6
Apr	73	22.5	3.2	14	5.2
May	74	22.5	3.3	14	5.3
Sept	38	22.5	1.7	14	2.7
Total	565	202.9	-	126.2	-
Ave	62.8	22.5	2.8	14.0	4.5
SD	14.7	0.1	0.7	0.1	1.1

Changes in buffalo abundance on Ordnance Annex from 1966-1996 are summarized in Figure 1, based on mean annual count results for this period (Anderson 1980, DAWR 1980-1995). The size of the base's herd remained fairly constant from 1966-1978, averaging about 0.6-0.8 animals/km traveled during counts. Since then, buffalo abundance has shown an increasing trend, although substantial variation in results can occur between years. Regression analysis shows that the population has shown a significant increase since 1966 ($y = 0.659 + 0.069x$, 95% CI of the slope = 0.069 ± 0.023, $r^2 = 0.604$, $P = 0.0001$). Illegal hunting continues to be a major cause of mortality in the population, as

noted by Conry (1988), but expanded anti-poaching efforts on the Annex by DAWR conservation officers and the Navy since the 1980s may be responsible for allowing the population to show steady growth. High buffalo densities have resulted in localized habitat damage on the base (Conry 1988, Biosystems Analysis Inc. 1989).

Figure 1. Results of water buffalo spotlight counts on Ordnance Annex from 1968-1996. Results are expressed as an annual mean of the number of animals seen per kilometer per count. Simple linear regression indicates that the rate of increase (slope) of buffalo is 0.069 (SE = 0.012) per year.



Preliminary discussions were held with the Navy and Guam National Wildlife Refuge this year on ways of controlling the buffalo herd size on the Ordnance Annex. The Navy is considering bringing in a specialist to assess the potential of using immunocontraception to reduce reproduction in the herd.

LITERATURE CITED

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Biosystems Analysis, Inc. 1989. Natural resources survey for the U.S. Naval Magazine, Guam (NAVMAG). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.

Conry, P.J. 1988. Management of feral and exotic game species on Guam. Trans. West. Sec. Wildl. Soc. 24:26-30.

Division of Aquatic and Wildlife Resources. 1980-1995. Job Progress Reports. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.

This report was prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam (1460, 1430)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Official logs with harvest statistics for wild pigs (*Sus scrofa*) were examined for Andersen Air Force Base (AAFB) and revealed a total of 6,203 hunter sorties, a harvest of 411 pigs, and a harvest rate of one pig per 6.9 hunter days. On Naval Computer and Telecommunications Area Master Station (NCTAMS), there were 1,711 hunter sorties, a take of 64 pigs, and a harvest rate of one pig per 12.2 hunter days. Harvest data were not available for other parts of Guam.

BACKGROUND

Wild pigs are Guam's most important game species in terms of total numbers of animals harvested. This species has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1967 (Conry 1988, DAWR 1967-1995). The island's wild pig population is descended from domestic *S. scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found island-wide, but appear to be most numerous in the secondary limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities in many forested areas that rooting and wallowing damage is common and can be quite severe locally. Depredation on agricultural crops is also a problem, especially in southern Guam. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations allow for a year-round season with bag limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations island-wide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Monitor hunter participation and harvest during the legal hunting season.

2. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.

RESULTS

Pig Hunting Statistics

Hunter questionnaires were discontinued this year because of a lack of manpower and low return rates in previous years, which may have resulted in biased sampling of the hunter community. The use of questionnaires as a management tool by the Division may be reinstituted in the future once a game biologist is hired.

Records of hunting activity and harvest were kept by officials at AAFB and NCTAMS throughout the year (Table 1). According to hunter logs from AAFB, 1,692.5 hunter-days (3,471 sorties; gun hunting only) were expended at Northwest Field and resulted in the harvest of 249 pigs. Hunting areas on the main portion of the base (Tarague basin, near the landfill, and areas north and east of the flightline) recorded 1,071.4 hunter-days (2,492 sorties; primarily bow hunting), with 149 pigs harvested. The Conventional Weapons Storage Area was not open to hunting this year. At Andersen South, 73.5 hunter-days (240 sorties; bow hunting only) were registered, with 13 pigs taken. At NCTAMS, 783.7 hunter-days (1,711 sorties) were expended, with a kill of 64 pigs. These records indicate a total harvest of 475 pigs on military lands.

Table 1. Hunter effort and wild pigs taken on Andersen Air Force Base and Naval Computer and Telecommunications Area Master Station (NCTAMS) during FY '96, based on official hunter logs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Andersen Air Force Base													
Northwest Field (gun hunting only)													
No. hunter sorties	687	648	580	103	108	128	102	175	182	50	142	566	3,471
No. hunter days (8 hr)	344.2	320.3	309.4	48.9	41.3	55.4	43.2	72.2	80.8	23.7	61.5	291.6	1692.5
Pigs taken	38	28	28	17	23	13	17	23	18	2	17	25	249
Days effort/take	9.1	11.4	11.1	2.9	1.8	4.3	2.5	3.1	4.5	11.9	3.6	11.7	6.8
Main Base (primarily bow hunting, except during the special hunt in July-August)													
No. hunter sorties	402	198	119	83	306	56	79	81	51	482	503	132	2,492
No. hunter days (8 hr)	164.8	61.8	44.3	35.0	155.2	20.1	28.8	27.7	16.9	217.7	253.4	45.7	1071.4
Pigs taken	16	15	11	9	20	5	5	16	6	13	23	10	149
Days effort/take	10.3	4.1	4.0	3.9	7.8	4.0	5.8	1.8	2.8	16.7	11.0	4.6	7.2
Andersen South (bow hunting only)													
No. hunter sorties	34	24	11	37	50	37	33		4	13			240
No. hunter days (8 hr)	12.3	5.9	3.4	16.3	12.2	8.9	8.1		1.1	4.8			73.5
Pigs taken	2	2	1	4	1	2	1		0	0			13
Days effort/take	6.2	3.0	3.4	4.1	12.2	4.5	8.1		-	-			5.7
NCTAMS (gun and bow hunting)													
No. hunter sorties	303	306	372	113	43	48	54	90	45	65	74	209	1711
No. hunter days (8 hr)	137.5	140.0	170.4	60.4	19.0	19.1	22.0	32.9	15.9	29.3	35.6	101.6	783.7
Pigs taken	4	11	10	7	4	0	2	7	1	1	8	9	64
Days effort/take	34.8	12.7	17.0	8.6	4.8	-	11.0	4.7	15.9	29.3	4.5	11.3	12.2

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases.

PROGRAM COST

The estimated cost of the wild pig project under W-1R-4 is $19,784.

LITERATURE CITED

Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dep. Agric., Mangilao. 60 pp.

Division of Aquatic and Wildlife Resources. 1967-1995. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.

This report was prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves (1460, 1430)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

The Spring Bird Survey conducted this year showed an increase in turtle–dove numbers over last year. Cross Island Road and Cocos Island recorded one or more birds per station.

BACKGROUND

The Philippine turtle-dove was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951) and has been regulated as a game bird since at least 1903 (Conry 1987). Up through the early 1960s, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960s, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970s and early 1980s. Turtle-doves are now found in appreciable numbers in prime dove habitat on NWF, CWSA and elsewhere on Andersen Air Force Base and at moderate numbers in selected areas of central and southern Guam. A large population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season in March 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.

2. To investigate nesting success and causes of nest failures.

PROCEDURES

1. Philippine turtle-doves were surveyed during spring bird counts conducted on 23 routes throughout the island in June. These surveys consisted of 5-minute station counts at up to 10 stations per route with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds observed per station.

Table 1. Numbers of Philippine turtle-doves detected per count and average number of birds per station on spring game bird surveys at various locations on Guam during May 1996. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1995 Ave./ Station	1996 Ave./ Station	Trend in Ave. 96-95
NORTH SURVEYS					
Tarague	10	2	0.4	0.20	-0.20
CWSA	10	5	0.7	0.50	-0.20
NWF	10	10	0.3	1.0	0.70
NCTAMS	10	4	0.2	0.40	0.20
Capitol Improvement Road	10	0	0.2	0.00	-0.20
MT. Santa Rosa	10	5	0.4	0.50	0.10
Y-Sengsong Road	10	9	0.2	0.90	0.70
Two Lover's Point	10	3	0.3	0.30	0.00
Andersen South	10	3	0.2	0.30	0.10
Navy Golf Course Barrigada	10	4	0.4	0.40	0.00
Barrigada Hill	10	4	0.3	0.40	0.10
Toto Pipeline	8	4	0.0	0.50	0.50
SOUTH SURVEYS	10	2	0.2	0.20	0.00
Nimitz Hill					
Reserve Craft Beach Road	4	2	0.3	0.50	0.20
Orote Point	6	4	1.0	0.67	-0.33
Pulantat	10	6	0.0	0.60	0.60
Cross Island Road	10	10	0.6	1.00	0.40
Naval Magazine	10	4	0.6	0.40	0.20
Umatac	10	6	0.0	0.60	0.60
Dandan	10	0	0.1	0.00	-0.10
Ija	8	7	0.6	0.88	0.20
Merizo	8	3	0.0	0.38	0.38
Cocos Island	10	14	2.3	1.40	-0.90

RESULTS

Spring Bird Surveys

Turtle-doves were recorded on 20 of 23 (87%) spring bird surveys conducted during 1996 (Table 1). Snake-free Cocos Island continues to have the highest count average, with 1.4 birds recorded per station. The Northwest Field, Cross Island Road, and Cocos Island routes were the only routes that had station counts ≥ 1.0 birds/station. Of the 23 routes surveyed, six (26%) recorded decreases, 14 (61%) recorded increases, and three (13%) recorded no change in the number of birds detected. There was a significant increase in numbers from last year's survey (Wilcoxon Signed-rank Test, $T_S = 64$, $Z = -1.52$, $p < 0.05$) (DAWR 1995).

RECOMMENDATIONS

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance, and population trends of turtle-doves.

2. Keep the turtle-dove hunting season closed until nesting success improves and the population recovers.

PROGRAM COST

The estimated cost of the Philippine turtle-dove project under W-1R-4 is $15,318.

LITERATURE CITED

Baker, R.H. 1951. The avifauna of Micronesia, its origin, evoiution, and distribution. University of Kansas Pub. 3(1):1-359.

Conry, P. J. 1987. Ecology of the Philippine turtle-dove on Guam. Tech. Report No. 6. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.

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Division of Aquatic and Wildlife Resources. 1995. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic Wildl. Res., Dep. Ag., Mangilao.

This report was prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Black Francolin on Guam (1460, 1430)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Black francolin *(Francolinus francolinus)* occurred on 17 of 23 spring bird survey routes conducted on Guam. Five survey routes showed decreases in bird numbers, four routes had increases of one or more birds, and eight routes had no change in the numbers per count. Overall, the northern surveys showed an increase in francolins while the southern surveys showed a decrease. This species appears able to sustain the current levels of recreational hunting.

BACKGROUND

In 1961, 171 black francolin were introduced to southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4-bird daily limit and a 20-bird season limit. Francolin populations continued to increase from 1980-1982, but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY83 to a 2-month split season, one month in January and one month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY90, extending the season from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons. Regulations implemented in FY83 remain in effect with hunter participation and adherence to game laws monitored by spot checks by Division of Aquatic and Wildlife Resources biologists and conservation officers.

OBJECTIVES

To determine current relative abundance and current distribution of black francolin on Guam and monitor population trends.

PROCEDURES

1. Conduct annual island-wide spring game bird surveys (station counts) to monitor distribution and status of francolin throughout the island.

RESULTS

Spring Bird Surveys

Black francolin were detected on 17 of 23 spring game bird surveys conducted during May 1996 (Table 1). Five survey routes had decreases, 4 routes had increases of 1 or more birds and 8 routes had no change in the number of francolin per count. Francolin were found on 9 of 11 surveys south of Route 4, which was no change from last year (DAWR 1995). They were found on 8 of 12 routes in northern Guam, an increase of two over last year's count.

Table 1. Numbers of black francolin observed per count and average number of birds observed per station as detected in spring bird surveys at various locations on Guam during May 1996. Values in the trend column are the difference between the average station count between years (Ave. = average).

Survey Location	No. Stations	No. Birds Observed	1995 Ave./ Station	1996 Ave./ Station	Trend in Average 96-95
NORTH SURVEYS					
Tarague	10	0	0.00	0.00	0.00
CWSA	10	0	0.00	0.00	0.00
NWF	10	3	0.00	0.30	0.00
NCTAMS	10	15	0.40	1.50	1.1
Capitol Improvement Road	10	5	0.00	0.50	0.5
MT. Santa Rosa	10	0	0.00	0.00	0.00
Y Sengsong Road	10	0	0.00	0.00	0.00
Two Lover's Point	10	9	0.90	0.90	0.00
Andersen South	10	5	0.50	0.50	0.00
Navy Golf Course	10	25	1.10	2.50	1.10
Barrigada Hill	10	15	2.00	1.50	-0.50
Toto Pipeline	8	2	0.00	0.25	0.25
SOUTH SURVEYS					
Nimitz Hill	10	34	3.60	3.40	-0.20
Reserve Craft Beach Road	4	0	1.50	0.00	-1.50
Orote Point	6	7	0.00	1.17	1.17
Pulantat	10	30	2.90	3.00	0.10
Cross Island Road	10	15	3.40	1.50	-1.90
Naval Magazine	10	19	4.70	1.90	-2.80
Umatac	10	27	4.3	2.70	-1.60
Dandan	10	55	4.60	5.50	0.90
Ija	8	33	7.25	4.13	-3.12
Merizo	4	22	4.00	5.50	1.50
Cocos Island	10	0	0.00	0.00	0.00

The northern survey route had an overall increase in the number of francolins recorded, as compared to FY95 (DAWR 1995). In contrast, the southern survey routes recorded an overall decrease in francolin numbers. However, two southern routes, Ija and Merizo, recorded the highest number of birds per station for the entire island. The Ija route recorded an average of 4.13 birds/station, while Merizo recorded an average of 5.50 birds/station.

Black francolin populations remain well established throughout southern Guam and in shrub-grass habitats in central and northern Guam.

RECOMMENDATIONS

Continue to monitor francolin population status, distribution, and hunter harvest.

PROGRAM COST

The estimated cost of the black francolin project under W-1R-4 is $13,909.

LITERATURE CITED

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JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUBPROJECT NO: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds (1460)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Roadside counts for native forest birds, cave censuses for island swiftlets (*Aerodramus vanikorensis*), and surveys for Mariana common moorhens (*Gallinula chloropus guami*) at Fena Reservoir continue to document the population trends of Guam's birds. Roadside counts in northern Guam recorded seven species of resident and migrant bird species. An average of 22.0 moorhens was recorded per count at Fena Reservoir, with a high of 24 birds and low of 20 birds. Censuses of swiftlets at Mahlac Cave revealed a large decline in the population (about 43%) in February and March, with only about 280 birds recorded in April and June. A trapping program at the cave captured 52 brown tree snakes (*Boiga irregularis*); several of these animals contained swiftlet feathers and eggshells in their intestinal tracts. Surveys of foraging swiftlets in the dry and rainy seasons indicated that the birds continue to feed primarily on the north side of the Talofofo River Valley, in the lower Ugum River Valley, and in the Asalonso area of Malojloj, Inarajan. Seven Mariana crows (*Corvus kubaryi*) were detected in the annual crow survey. The total number of crows remaining on the island is estimated at about 14 birds, which reveals a further decline in the population during the last year.

BACKGROUND

Predation by brown tree snakes is the major factor in the decline of most of Guam's native bird species during the last few decades (Savidge 1987, Conry 1988, Engbring and Fritts 1988). Census data from a variety of sources have documented the extirpations of eight species, while four others have undergone severe population decreases, both in terms of overall numbers and geographic range (Division of Aquatic and Wildlife Resources [DAWR] 1963-1995, Engbring and Ramsey 1984, Wiles et al. 1995).

Common moorhens continue to be scattered throughout the southern and central parts of Guam, with recent population estimates placed at 100-125 birds (Stinson et al. 1991). Island swiftlets occur primarily in one large colony on Naval Ordnance Annex (formerly Naval Magazine). Three much smaller colonies are also known and occur on the Ordnance Annex, in the Lumuna district of Yigo, and in the vicinity of the Geus River Valley in Merizo (DAWR 1987-1995, Wiles et al. 1995). Mariana crows are now restricted to Andersen Air Force Base (AAFB) (DAWR 1992-1995, Wiles et al. 1995). Their population had declined to an estimated 24 birds in 1995 (DAWR 1995). A small population of Micronesian starlings also persists on the island, with most birds remaining on AAFB and Yigo, while smaller numbers occur on Cocos Island and coastal areas of southern Guam (DAWR 1991-1995, Wiles et al. 1995). Recovery plans have been written for each of these species except the starling (Beck and Savidge 1990, U.S. Fish and

Wildlife Service 1991a, 1991b). In addition, the island continues to retain small to moderate numbers of several other resident bird species, as well as migratory shorebirds, seabirds, and waterfowl.

OBJECTIVES

To continue status surveys and natural history studies as called for in the recovery plans for Guam's endangered native birds (Beck and Savidge 1990, U.S. Fish and Wildlife Service 1991a, 1991b).

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes (North, North-Central, and Northwest Field; see previous annual reports for locations of routes) in northern Guam by DAWR conservation officers. These routes were driven at approximately 15-25 kph beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.

2. Several surveys for common moorhens were conducted at Fena Reservoir on Ordnance Annex. Two or three observers paddled a canoe to the southern end of the reservoir before sunrise. The count began shortly after sunrise with the canoe paddled northward along both shorelines of the reservoir. Locations of moorhens seen and heard were recorded.

3. Monthly visits to Mahlac Cave on Ordnance Annex were made to monitor the island swiftlet colony. When counts were conducted, observers sat at both entrances of the cave for a period of 1-2 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. During all visits, observers entered the cave for about 1 hr (prior to any counts) to record numbers of nestlings and listen for their calls. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by using a mirror to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead and of snake tracks found in the guano.

4. Recorded-call playback surveys for Mariana crows were conducted in northern Guam. At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period during which the observer listened for crows. The numbers, distance, and plumage condition of the crows observed were recorded.

RESULTS

Roadside Counts

Roadside counts continue to document the status of birds in northern Guam (Table 1). Six species were observed on the North count, with all displaying increases in abundance.

Six species were recorded on the Northwest Field route, including one Mariana crow. Each of these species showed increased detections over last year. Although black francolins were not observed on this route this year, the species was detected on the spring bird count.

Six species were noted on the North-Central route. All species recorded decreases except the Eurasian tree sparrow, which continues to increase on this count.

Table 1. Results of North, Northwest Field, and North-Central roadside counts showing the mean (±SD) number of birds recorded per 100 km of travel.

	North		Northwest Field		North-Central	
	No. per		No. per		No. per	
Species	100 km	SD	100 km	SD	100 km	SD
Yellow bittern	1.7	1.1	14.2	6.0	6.5	1.4
Black francolin	2.9	1.9	0	0	9.1	2.0
Pacific golden-plover	44.5	23.9	93.8	17.2	56.1	19.1
Philippine turtle-dove	15.4	4.6	28.7	4.6	17.1	2.0
Black drongo	10.3	3.5	17.2	2.9	5.9	1.5
Mariana crow	0	0	0.3	0.3	0	0
Eurasian tree sparrow	78.0	27.8	5.9	1.8	201.9	17.2
number of counts	21		23		23	

Common Moorhens

Only two moorhen surveys were conducted at Fena Reservoir during FY96 (Table 2). Surveys averaged 22.0 birds per count. Nearly all moorhens (43 of 44) were recorded in the southern two-thirds of the reservoir. Nests were found on both surveys, but only two nests in January held eggs. One contained four eggs, while the other had two eggs. A group of three juveniles and two adults was seen in January.

Table 2. Numbers of common moorhens and nests recorded during surveys at the Fena Reservoir in FY96.

Date	Adults	Juveniles	Chicks	Unknown	Total birds	No. of nests	Reservoir water level (ft)
10 Jan	24	0	0	0	24	3	111
22 Mar	15	3	0	2	20	5	111

Observers saw common moorhens at a number of other locations on Guam during the year. The most significant finding involved the rapid colonization of a new mitigation wetland along Dry Dock Island Road in Piti, which was built as part of the new Southern High School project. Observations revealed that moorhens colonized the site while pond construction was still underway in February or March, but close monitoring of the population was never achieved during the year. On 4 April, five pairs of moorhens and two nests under construction were noted, with at least a sixth pair found later that month. Birds have inhabited every major sub-unit of the wetland since then, and several more nests were found. Moorhens continued to occupy the site through September and were also noted in the natural marsh bordering the service road immediately to the south. Despite the apparent success of this project in attracting moorhens, several potential problems warrant concern. The north side of the site suffered from weed encroachment of open ground during the dry season. Considerable maintenance may be required in the future to keep certain areas free of weeds. Heavy mats of algae have also been noted in the main body of water, which are suggestive of an initial water quality problem. Portions of the large beds of *Eleocharis* reeds established soon after completion were showing considerable browning, but no actual dieback, by September. Time will tell whether these problems become significant management concerns, and whether they will reduce the attractiveness of the site to moorhens.

Other moorhen records of interest included a bird seen from February to late April at a small inadvertently formed roadside pond along Route 4 in Chalan Pago, a bird seen in a

Other moorhen records of interest included a bird seen from February to late April at a small inadvertently formed roadside pond along Route 4 in Chalan Pago, a bird seen in a large flooded lawn in front of the Temple Baptist Church in Conga, Chalan Pago in early February, a bird heard in the flooded fields south of the Department of Agriculture in Mangilao on 25 October, and a bird heard in a *Phragmites* marsh just north of the Namo River bridge in Santa Rita on 19 December.

Native Doves

No Mariana fruit-doves or white-throated ground-doves were recorded on Guam this year.

Island Swiftlets

Mahlac Cave - The swiftlet population at this cave declined severely during FY96. Censuses were not conducted between October and January, but general observations of bird activity indicated that the population was probably similar to that determined in September 1995, when an all-time high count of 495 was obtained. A visit in late January found that the onset of the nesting season was proceeding normally and that good numbers of chicks and eggshell fragments were present in the cave (Table 3). Follow-up visits on 5 and 28 March found very little daytime visitation by adults and revealed unusually low numbers of chicks and eggshell fragments for this time of the year, along with unprecedented numbers of whole eggs on the cave floor. Examination of the fallen eggs revealed many well-developed embryos, which contrasts with the normal pattern for fallen eggs where embryo development is usually not seen. Four censuses were made over the next 10 weeks and verified that the cave's population had indeed fallen to about 280 birds (the census on 5 June was judged to be inflated) (Table 3). Fortunately, cave visits from late April to late August revealed no further declines in bird activity and found that nesting had returned to relatively normal levels for a population of this size.

Table 3. Results of censuses for island swiftlets at Mahlac and Fachi Caves on Ordnance Annex during FY96. Evidence of reproductive activities of swiftlets is also presented.

				Reproductive Parameters					
Date	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	No. of Whole Eggs Found on Cave Floor	No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen small	med	large
Mahlac Cave									
27 October 1995	-	-	-	0	3	2-3	0	1	5
28 November	-	-	-	1	0	2	0	0	1
28 December	-	-	-	1	7	3	2	3	0
29 January 1996	-	-	-	2	17	5+	5	3	4
5 March	-	-	-	8	10	2-3	1	2	4
28 March	-	-	-	10	8	1-2	0	2	3
2 April	254	30	284	-	-	-	-	-	-
30 April	258	25	283	5	20	2-3	3	2	0
5 June	289	45	334	4	32	3-4	4	11	3
11 June	252	29	281	-	-	-	-	-	-
27 June	-	-	-	5	11	2-3	1	6	12
30 July	-	-	-	4	18	2-3	0	1	5
28 August	-	-	-	3	14	5+	3	7	4
7 October	-	-	-	1	5	3-4	1	2	5
Fachi Cave									
13 June	10	12	22	-	-	4-5	-	-	-
18 June	14	14	28	-	-	-	-	-	-

Key: - = no data gathered.

From this evidence, we believe that the colony experienced some type of disturbance during February and probably March that caused a loss of about 43% of its resident birds. Aside from one recently fledged juvenile found dead on the cave floor on 5 March, no significant numbers of dead birds were observed in the cave. Additionally, no evidence of human or natural disturbance was found. This suggests that disease, vandalism, or ungulate presence inside the cave, were not responsible. The large numbers of whole eggs (in all stages of embryo development) fallen from nests suggests that adults were disturbed off their nests on at least several occasions, and perhaps repeatedly, by noise outside the cave or by some cause inside the cave. The lack of any obvious animal tracks in the guano indicates that if a predator was present, it was most likely snake, monitor lizard, or cat moving along the walls of the cave. Snake trapping (described below) was initiated in an effort to remove any impact these animals might be having. Observers noted a monitor lizard climbing on a cave wall inside the north entrance on the afternoon of 27 June, and a feral cat was recorded on videotape inside the cave under the main group of active swiftlet nests on the night of 28 July. Further speculation on the cause of the swiftlet decline can not be made. This event resembles another decrease noted at Mahlac Cave in June and July 1988, when the population fell from an estimated 450-475 birds to 210 birds (DAWR 1988). The cause of that decline was never determined either, and in both cases, the fate of the missing birds was never resolved.

Snake trapping was conducted at the cave in cooperation with the USFWS from 5 April to 9 August, with a total of 1,027 trap nights achieved. Trapping was accomplished with 6-12 mouse-baited funnel traps set inside the cave and along the crevice outside of the cave's south entrance. A total of 52 snakes (19 inside, 33 outside) were caught during 540 trap nights inside the cave and 487 trap nights outside the cave. Seven animals were captured inside the cave during the first 10 days of trapping, with fewer individuals trapped inside during the rest of the project. This suggests that new snakes colonized the cave as resident animals were removed.

Most (96.2%) of the snakes had snout-vent lengths of 81-105 cm, but one large individual measured 174.3 cm. Most (76.5%) were females. One snake contained a large number of swiftlet pinfeathers in its intestine, indicating it had captured a medium or large-sized chick in a nest. A lack of numerous tiny insect parts associated with the feathers suggested that the chick had not fallen first onto the guano of the cave's floor. Three more snakes held a few small feathers in the alimentary tract, and two others contained swiftlet eggshell fragments. One snake with eggshell parts also contained guano, showing that it had scavenged the egg off the cave floor. From these data, it is evident that more snake predation is occurring on swiftlets at Mahlac Cave than previously believed.

Three other birds were found dead on the cave floor during the year. These were a large nestling on 12 April, a medium-sized nestling on 5 July, and an adult or fledged juvenile on 12 July. This amount of mortality has not been previously observed in the since studies began in 1987, but most likely reflects the increased number of visits made to the cave this year by USFWS staff. This indicates that at least some swiftlet mortality is occurring that is not associated with snake predation.

Reproductive activity in the colony continued to be monitored this year. Chick production was viewed monthly at the 63-68 nests and was generally highest from January through August, except for the dip in production that coincided with the cave's population decline in February and March (Table 4). This agrees with information gathered in previous years, with most reproduction beginning in January and continuing until September or October (DAWR 1987-1995).

During the last half of FY96, the USFWS began monitoring swiftlet activity and snake presence in the cave using a video camera system. Preliminary viewing of videotapes noted pairs of snakes on the cave wall below the swiftlet nests on 12 and 13 August. A more complete analyses of this work will appear at a later date.

Fachi Cave - Two censuses were made at Fachi Cave on 13 and 18 June (Table 3). They resulted in fairly accurate counts of 22 and 28 birds, respectively, and indicate that there is some variation over short periods of time in the number of birds roosting at this site. The counts revealed that the number of birds in this cave has also declined, and suggested that none of the birds, which disappeared from Mahlac Cave, moved to this site. The last count conducted here was in August 1994, when an estimated 55-70 birds were present (DAWR 1994).

As in most previous years, heavy rains in September-October 1995 and September 1996 again caused flooding of the sinkhole outside the cave's east entrance. The water level rose to within 45 cm of the top of the entrance on 27 October and 7 November, and was within 15 cm of the top on 20 September. It was not determined if the water levels went higher than this or if birds were forced temporarily to abandon the cave.

Firebreak 3 Cave - Visits to this cave revealed that it continued to remain unoccupied after the decline at Mahlac Cave.

Other Localities - No searches were made during FY96 for the suspected swiftlet colonies in the Lumuna region of Yigo and the Geus River Valley in Merizo.

Surveys of Foraging Birds - The DAWR assisted the USFWS in conducting two surveys of foraging swiftlets in the Talofofo River Valley and surrounding areas. The surveys were conducted in the dry season from 29 April - 25 June and in the rainy season from 23 August - 16 October. They were similar in technique to the previous survey made in 1989 (DAWR 1989), except that 18 additional stations were included, giving a total of 70 stations per survey, and only a single count was made at each station during each survey. Generally, the counts revealed that the dry season foraging range of the swiftlet population was similar to that determined in 1989 (DAWR 1989), with most birds seen on the north side of the Talofofo River Valley, in the lower Ugum River Valley, and in the Asalonso area of Malojloj, Inarajan. However, during the rainy season, when prevailing winds blew primarily from the south and the west, counts indicated that there was some change in foraging distribution. Birds appeared to be distributed over a larger area, although the same primary feeding areas continued to be used. Birds were recorded on 28 (40.0%) of 70 stations in both surveys. Further details of this work will appear at a later date.

Mariana Crows

Fourteen transects totaling 211 stations were used to survey crows in eight regions of northern Guam during July. Transect locations were previously described in DAWR (1990, 1991). Crows were present on 3 (2.1%) transects, which is a slight increase of over last year's survey (Table 4). A total of 7 crows were recorded during playback surveys, including: 11B6, recorded twice; C1 singleton (a female), recorded four times; and a single bird in the C3 area of Northwest Field (Figure 1).

The number of birds detected during this year's survey is lower than the actual number of birds still surviving (Figure 1). Four birds were recorded on Transect 1 in the Conventional Weapons Storage Area (CWSA), but these represented two birds (the C1 unmated bird and one bird from the 11B6 pair) seen twice. Based on other observations during the year, five birds (the 11B6 and 15B3 pairs and the C1 single bird) are known to

inhabit this area. At the Pati Point area, at least four birds are still present, including the WSA pair and two individuals (the Pipeline and Pati Point singletons), but these were missed on Transect 7. Another pair in the Tarague basin was not recorded on Transect 10.

Table 4. Summary of results from playback of tape-recorded Mariana crow calls conducted in July and early August 1996. Transect locations are described in DAWR (1990, 1991).

Transect	No. of stations	No. of crows	No. of stations with crows	Known no. of crows missed in survey
1	50	4	2	1
2	36	2	2	0
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	4
8	23	0	0	0
9	8	0	0	0
10	9	0	0	2
11	7	0	0	0
12	8	0	0	0
13	8	1	1	0
14	9	0	0	0
Total	211	7	5	7

Population estimate = 7 + 7 = 14 birds

When the number of birds recorded during the survey (excluding repeats) is added to the missed birds, a total estimate of about 14 birds is obtained and represents a better approximation of the actual size of the Guam population. This estimate suggests the island's population decreased 38% during FY96. Several pairs were known to have lost one or both birds. These include pairs from Northwest Field (the former Area 10 pair), CWSA, and the Pati Point area (the Pipeline pair lost a mate).

Results of this survey further verify the worsening state of Guam's crow population. Though snake-proofing has been used successfully to prevent snake predation of crow nests, factors such as egg inviability and embryonic death have thwarted efforts to increase reproductive success. Though major strides have been made in increasing egg production, egg inviability continues to plague the remaining population of breeding birds. The male of the breeding pair in area C1 was feared dead after their clutch was laid. Translocation is believed to be the only means of saving the population on Guam.

Micronesian Starlings

No data were gathered on the starling populations at either AAFB or Cocos Island. Implementation of a proposed nest box program for birds on AAFB failed to progress again this year (see DAWR 1994). It is hoped that this pilot project will proceed in FY97.

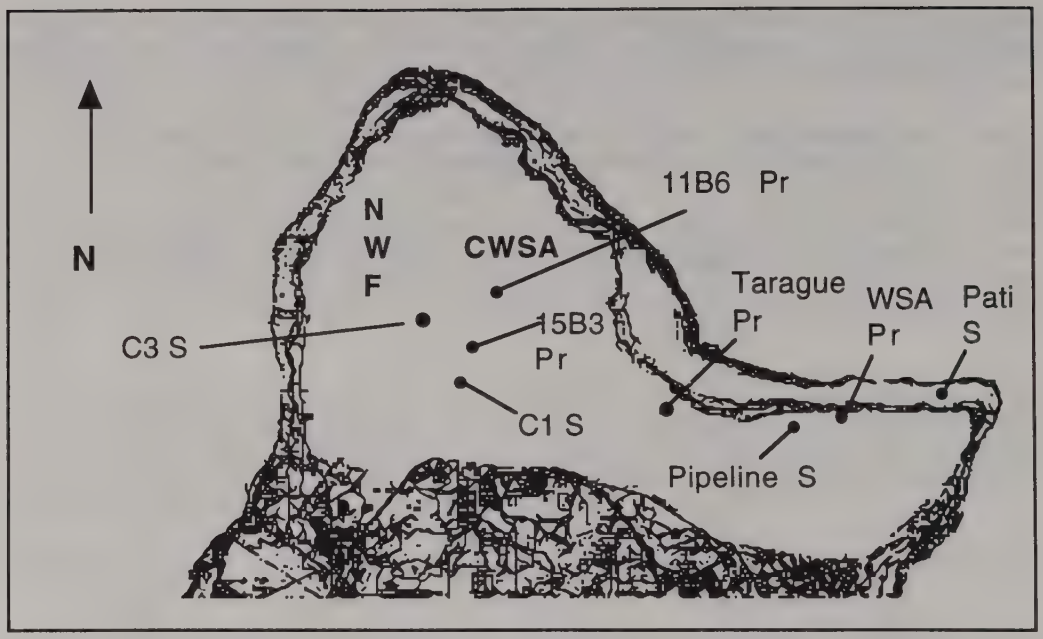

Figure 1. Location of Mariana crows, pairs (Pr) and single birds (S), on Andersen Air Force Base (NWF = Northwest Field, CWSA = Conventional Weapons Storage Area, WSA = Weapons Storage Area). Seven crows were detected during the July-August survey, but the actual number of birds remaining on the island is estimated to be about 14 birds. Not included on the map are two unmated birds (one banded) which roam part of the CWSA.

Notable Species Recorded on Guam during FY96

Noteworthy records of birds for Guam in FY96 are presented here. Again this year, unusually large numbers of ducks resided at a man-made pond at the Manengon Hills Resort in Yona during several winter months. The highest count of the flock occurred on 14 December, when 39 tufted ducks (*Aythya fuligula*), 20 northern pintails (*Anas acuta*), and 2 green-winged teal (*Anas crecca*) were noted. A male gadwall (*Anas strepera*) was recorded on Fena Reservoir on 10 January.

Raptor sightings were much reduced this year from FY95. A large hawk was seen repeatedly roosting and flying on Nimitz Hill from 16 October-23 December. The bird was thought to be a black kite (*Milvus migrans*), although its ragged plumage, including some white coloration, and missing tail feathers made positive identification difficult. Another hawk fitting this same description, and probably the same bird, was noted on four more occasions on Nimitz Hill and Ordnance Annex between 2 April and early August. Three unknown accipiters (*Accipiter* sp.) were observed flying over Nimitz Hill on 23 December.

Three to four juvenile black-winged stilts (*Himantopus himantopus*) remained at the Manengon Hills artificial pond in Yona from 9-14 December. Two common black-headed gulls (*Larus ridibundus*) were sighted at the Agfayan Bay fish ponds on 23 December. A great crested tern (*Sterna bergii*) flew along the reefline at Togcha Beach, Yona on 24 May. A flock of 10 whiskered terns (*C. hybridus*) was seen at several ponds at the Shell Oil Refinery, Piti on 15-16 October. The Agfayan Bay fish ponds attracted six more of these terns on 23 December, as well as six white-winged terns (*Chlidonias leucopterus*) on 15 October, and pairs of *C. leucopterus* on 23 December and 15 September. A fork-tailed

swift (*Apus pacificus*) occurred at the Ritidian Point cliffs on 11 October. A barn swallow (*Hirundo rustica*) foraged low over buildings and a parking lot next to the Paseo baseball stadium in Agana on 28 September. Four yellow wagtails (*Motacilla flava*) were present in short grassy fields next to the cliffline at Pati Point from 20-28 September.

The pair of common mynas (*Acridotheres tristis*) reported last year from the former USO building in Piti (DAWR 1995) were not observed this year during two visits, and there were no further reports of these birds by the public.

RECOMMENDATIONS

1. Develop and implement methods for controlling the brown tree snake.

2. Continue to monitor the population of common moorhens and develop an appropriate habitat improvement and development program.

3. Continue monthly cave censuses and efforts to assess population change and reproductive activity of island swiftlets. Consider snake-proofing Mahlac Cave to protect nesting swiftlets. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofofo River valley about the use of pesticides on their farms.

4. Continue to census the Mariana crow in order to estimate population size and distribution. Continue breeding biology studies and attempts to snake proof nest sites of crows.

5. Continue predator control efforts on Cocos Island until complete eradication of monitor lizards and feral cats is attained.

6. A review of ongoing and completed wetland mitigation projects should be made to assess the success of these projects. The evaluation should be done in cooperation with other Government of Guam agencies, the U.S. Army Corps of Engineers, the USFWS, and private sector consultants.

PROGRAM COST

The estimated cost of the non-game bird project under W-1R-4 is $58,052.

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This report was prepared by: Gary J. Wiles and Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUBPROJECT NO: W-4
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Survey for Mariana Crows and Their Nest Sites (1460, 1470)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

This research project segment is reported in Project No. W-1R-4, Study 1, Job 1 (Survey and Inventory of Non-Game Birds) and Project E-1-11, Study 7, Job 3 (Development and Testing of Control Methods for Enhancing Reproduction Affected Endangered Native Forest Birds and Fruit Bats).

PROGRAM COST

The estimated cost of the non-game bird project under W-1R-4 is $105,152.

This report was prepared by: Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Current Status, Distribution, and Natural History of Mariana Fruit Bats (1410, 1440, 1450)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

During FY96, Guam's fruit bat population ranged in size from an estimated high of 370-410 animals in March to a low of 230-265 animals in July, which is a decline of about a hundred bats from last year. The island's only bat colony continued to roost at a single site on Pati Point for the second consecutive year. A limited survey of the Naval Ordnance Annex (formerly Naval Magazine) by the U.S. Fish and Wildlife Service (USFWS) found very few bats. One possible illegal hunting incident was reported this year. There is evidence of a small amount of fruit bat smuggling into Guam.

BACKGROUND

The Mariana fruit bat (*Pteropus mariannus mariannus*) has been studied by the DAWR since 1962 (DAWR 1964-1995). Considered a delicacy by Chamorro residents, bat abundance declined during the 1960s and 1970s until only a few solitary animals remained (Perez 1972, Wheeler and Aguon 1978, Wiles 1987a). A second species, the little Mariana fruit bat (*P. tokudae*), also occurred on the island, but is now extinct (Wiles 1987a). Reasons for the declines were primarily overhunting and some loss of habitat (Wheeler 1979). Both *Pteropus* have been placed on the U.S. and Guam Endangered Species Lists. The island's population of Mariana fruit bats grew to an estimated 850-1,000 animals in the early 1980s, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass 1990). However, numbers have gradually declined since 1983 because of continued illegal hunting and suspected predation by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b, Wiles et al 1995). During FY95, Guam's fruit bat population ranged in size from an estimated low of 300-345 animals in October to a high of 440-500 animals in January (DAWR 1995).

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as recommended in the Mariana Fruit Bat Recovery Plan (Wiles 1990).

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the CNMI as initiated in the late 1970s.

    a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.

b. Conduct monthly censuses at known bat colonies on Guam.

c. Assist the CNMI Division of Fish and Wildlife with surveys of fruit bats on other islands as needed.

2. Record information on the behavior and reproduction of fruit bats in colonies.

3. Determine habitat use of fruit bats. Visit abandoned roost colonies and record information about terrain and the size and abundance of vegetation present.

4. Monitor fruit bat imports to Guam from other Pacific islands.

5. Investigate illegal hunting of fruit bats on Guam. Visit abandoned roosting sites of colonies to determine illegal hunting effort. Assist conservation officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

The island's only known fruit bat colony resided at Roost 1 on Pati Point at AAFB throughout FY96 (Tables 1 and 2). This location has been a preferred roosting site for many years (DAWR 1987-1995).

Table 1. Approximate dates of use of the roost used by the only known colony of Mariana fruit bats on Guam in FY96.

Roost Number	Roost Location	Approximate periods of use by bats
1	North Pati Point	2 July 1994 - present

Surveys of Fruit Bats on Guam

Counts at Roost 1 were relatively low throughout the year, in comparison to censuses in previous years (DAWR 1981-1995). Counts peaked at 266 fruit bats in early March and declined to a low of 141 bats in late July (Table 2). This pattern generally follows a trend observed in recent years of larger counts during the winter months and reduced counts from May-September (DAWR 1994). Data analyses indicate that bat numbers on Guam and Rota fluctuate inversely with one another and are highly suggestive of seasonal inter-island movements (Wiles et al., in prep.).

Estimates of fruit bat numbers at the main colony on Pati Point can be made using the high and low roost counts for the year. Because some individuals were probably hidden by thick foliage during counts, the total number of adults in roosts was likely to be 5-10% higher than the actual number recorded. In addition, based on observations made in August 1994, approximately 52% of the adults in the colonies were harem females (DAWR 1994). About 10% of these animals possessed unweaned young. These figures provide an estimated high of 279-293 adults and 15 juveniles, or a total of 294-308 bats during early March, and a low of 148-155 adults and 8 juveniles, or a total of 156-163 bats in July.

Table 2. Counts of Mariana fruit bats at roosts on Andersen AFB, Guam in FY96.

	Roost Number								
Date	1	14	15	16	17	18	19	20	21	Total
2 Oct 1995	246	0	0	0	-	0	0	0	0	246
25 Oct	219	0	0	0	-	0	0	0	0	219
29 Nov	249	-	-	-	-	-	-	-	-	249
29 Dec	254	-	-	-	-	-	-	-	-	254
2 Feb 1996	241	-	-	-	-	-	-	-	-	241
11 Mar	266	-	-	-	-	-	-	-	-	266
29 Mar	245	0	0	0	-	0	0	0	0	245
25 Apr	221	0	0	0	-	0	0	0	0	221
31 May	215	-	-	-	-	-	-	-	-	215
28 June	148	0	0	0	-	0	0	0	0	148
31 July	141	0	0	0	0	0	0	0	0	141
27 Aug	158	-	-	-	-	-	-	-	-	158
8 Oct	168	-	-	-	-	-	-	-	-	168

- = site was not checked for bats

Personnel from the USFWS made a brief survey of bats on the Ordnance Annex between 24 June and 10 July (J. Morton, unpubl. rept.). Nine counts were made at eight early morning stations, with three single bats seen. Two were noted in the Mt. Almagosa area, while the third was near the south end of Fena Reservoir. Morton (unpubl. rept.) gives a summary of 23 bat sightings made on the Annex since 1984, which represents most of the sightings recorded on the base during this period.

A number of incidental daytime sightings of single fruit bats or pairs of bats were made around the island this year, including: Northwest Field (2 sightings), Urunao Beach (3 sightings), Falcona Beach (1 sighting), Conventional Weapons Storage Area on AAFB (2 sightings), Tarague Beach (3 sightings), the Dog Kennels area of AAFB (3 sightings), Andersen South (1 sighting), the Navy golf course in Barrigada (3 sightings), along Route 16 southwest of Mt. Barrigada (1 sighting), Cotal Conservation Reserve (1 sighting), Ordnance Annex (4 sightings excluding those already noted above), and along the dirt road up to Mt. Sasalaguan in Inarajan (1 sighting). A large number of nighttime sightings were also reported, with two at Northwest Field, two at Tarague Beach, one along Route 3A near Potts Junction, one at Naval Computer and Telecommunications Area Master Station, two near Ysengsong Road in Gugagon, Dededo, two in the Cotal Conservation Reserve, and three on Ordnance Annex.

Excluding bats residing in the colony at Pati Point, an estimated 50-75 fruit bats are still believed to live solitarily or in small groups in northern Guam, primarily along the cliffline extending from Bijia Point to Iates Point. An additional 25 animals probably inhabit the Ordnance Annex and other forested areas in southern and central Guam. Based on these figures, Guam's island-wide population of fruit bats varied from an estimated high of 370-410 animals in March to a low of 230-265 animals in July.

Surveys of Fruit Bats on Other Islands

The DAWR did not assist in any bat surveys in the CNMI during FY96.

Illegal Hunting

Poaching has long been a major cause of mortality of *P. mariannus* in the southern Mariana Islands (Wiles 1987a, Wiles et al. 1989, Stinson et al. 1992). Poaching still occurs commonly on Rota and other islands in the Marianas (D. Worthington, pers.

comm.). With the termination of legal bat imports from Palau on 1 October 1994, it was feared that increased poaching activity might occur throughout the archipelago (Wiles 1994). Fortunately, there is no evidence that this has happened on Guam. A second-hand report of illegal hunting at the colony on Pati Point was obtained in December, but follow-up observations showed no changes in bat roosting patterns there that would have likely resulted from hunting. Also, the presence of bats at the roost prevented biologists from searching for other supportive evidence, and thus the report could not be verified.

Reports were received of at least five hunting incidents on Rota during the year, with many more likely to have occurred. Four of these were late September, just a few weeks before the Rota fiesta (K. Garlick, pers. comm.).

Fruit Bat Imports

No legal shipments of fruit bats entered Guam this year. However, several illegal shipments were confiscated by customs authorities during the year (K. Garlick, pers. comm.). These were as follows: 3 bats (species not identified) from Okinawa on 19 June, 2 bats from Palau on 15 July, 2 bats (species not identified) from Saipan on 6 August, and 9 bats from Palau on 29 August.

Termination of bat imports from Palau in 1994 caused fears that increased smuggling of bats into Guam from other neighboring islands might occur (Wiles 1994). To assess the extent of this problem, USFWS agents inspected 100 coolers arriving from Palau and the Federated States of Micronesia during a 5-day period in mid-November (K. Garlick, pers. comm.). No bats were found in any of the containers. The DAWR received a single report of an island resident consuming bats during the year. Also, a visitor to Chuuk in May was told that some bats were still being killed for shipment to Guam. These few records may indicate that smuggling is not occurring to any great extent on the island. However, the situation is probably considerably different in the CNMI. K. Garlick (pers. comm.) of the USFWS was told by a CNMI government official that fruit bats were readily available for anyone seeking them on Saipan. It was not clear whether these were bats smuggled into the CNMI or animals shot on the islands north of Saipan. Customs authorities on Saipan confiscated three single bats from people entering the island during the year. All of the bats came from Palau.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota can cause large numbers of bats to move to Guam (Wiles and Glass 1990).

2. Continue observations at Guam's bat colonies. Information on reproductive biology, behavior, and social organization will be used to supplement data already gathered.

3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.

4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.

5. Known bat roosting and foraging areas should be patrolled regularly by DAWR conservation officers. Part of their effort should be aimed at maintaining a visible

presence at Jinapsan and Pajon Points, where poaching has been a serious problem in previous years.

6. Continue to assist the CNMI as needed with island censuses and other biological studies. Studies conducted on Rota would be most valuable for understanding the aspects of Guam's fruit bat population.

7. Continue to monitor illegal fruit bat imports entering Guam.

PROGRAM COST

The estimated cost of the fruit bat project under W-1R-4 is $33,340.

LITERATURE CITED

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Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 4

JOB TITLE: Roost Site Characteristics of Mariana Fruit Bats

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

No significant effort was expended on this job during this segment.

This report was prepared by: Gary J. Wiles

PROGRESS REPORT
COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-4
SUB-PROJECT NO.: W-6
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Wildlife Resources (1210)

PERIOD COVERED: October 1, 1995 to September 30, 1996

BACKGROUND

The Wildlife Section professional staff of the Division of Aquatic and Wildlife Resources (DAWR) devoted a significant percentage of their time and effort to technical assistance. The pace of development on the island is requiring increasing amounts of time from the Section's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications most of which are local Government of Guam or private sector. In addition, the Section also provides comment and review of numerous activities and proposals from the military bases on Guam that may affect Guam's endangered species and wildlife resources and their habitat. Often this includes commenting on U.S. Fish and Wildlife Service (USFWS) Section 7 consultations concerning impacts of military projects on endangered species. Because of the size and complexity of some of these developments, the Section's review responsibility will require a continuing commitment that often extends beyond project completion.

The professional staff in the Wildlife Section provide technical support to the Division's technical assistance program staff and often take the lead in the review of projects involving their particular expertise, such as those that may have endangered species impacts or those involving wetlands. This effort is extremely important for the management and conservation of Guam's natural resources.

OBJECTIVES

1. To minimize adverse environmental impacts resulting from the construction of recreational, commercial, residential, industrial, military, or public utility facilities.

2. Provide technical assistance to farmers and other landowners, including private, territorial, and federal, for controlling wildlife damage to crops, native habitat, and other property.

3. Provide technical assistance to military and civil agencies relative to the management and protection of Guam's wildlife resources.

4. Provide data and analyses to assist the Department in promulgating hunting regulations for the Territory to provide recreational opportunities for the public, control damage to native habitat, and other needs as they arise.

FINDINGS

Wildlife Section staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications that were submitted to the Division for review required the Wildlife Section's assistance. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Section staff members actively serve as members of the following groups:

1. Region IX Regional Response Team - Oceania

2. Fish and Wildlife Natural Resource Committee- Andersen Air Force Base

3. Pacific Islands Recovery Team for Birds and Bats, USFWS

4. Captive Breeding Working Group, USFWS

5. Area Committee for Oil Spills

Members of the Wildlife Section have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Section staff maintain close liaison with the Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), USFWS, U.S. National Marine Fisheries Service, U.S. Navy, Coast Guard, and Air Force regarding matters of environmental concern. In addition, staff members actively consulted with numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Wildlife Section staff Biologist's III Gary Wiles and Celestino Aguon participated in a USFWS Pacific Islands Recovery Team meeting on Rota in December 1994. Mariana Islands endangered species recovery efforts were the focus of the meeting.

Considerable public contact was maintained by section staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members gave talks to a number of civic groups, sportsman clubs, and school and university classes.

Some more specific Technical Assistance activities of the Wildlife Section included:

1. Continued to participate with Guam Environmental Protection Agency, the Department of Education, USFWS, and ACOE to resolve wetland mitigation issues associated with the construction of the Southern High School in Agat.

2. The Division was represented on the Development Review Committee by its technical review staff, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and wildlife resources to be considered in land use planning. Wildlife professional staff provided significant technical input into this review process at various levels on numerous occasions.

3. The Division reviewed and commented on ACOE applications for wetland fill. Mitigation recommendations were often included in these comments. Comments and concerns were also provided to various local agencies. Wildlife staff provided

significant input into the responses for these applications. Endangered species were of primary concern to the Section with Mariana common moorhens found in most wetlands on Guam.

4. The Section provided technical support to the Division's enforcement staff by identifying and evaluating wildlife, testifying at court hearings, and recommending disposition for confiscated wildlife.

5. Section staff provided technical assistance to the Department of Agriculture's Plant Protection Quarantine Division by identifying confiscated wildlife and wildlife products, holding wildlife in quarantine, and in general supporting their efforts at preventing illegal imports of wildlife to Guam.

6. The Division reviewed and commented on numerous Environmental Impact Statements/Assessments of proposed developments particularly when wildlife issues were present. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce and/or eliminate impacts to the immediate and adjacent environments.

7. The Division's Wildlife Section provided comments at the request of the USFWS for numerous Section 7 Consultations under the Endangered Species Act, including the following:

    a. Several construction projects at U.S. Naval Magazine Guam.
    b. Numerous military training exercises at AAFB and Naval bases on Guam.
    b. Several wetland related development activities for civilian and military projects.

8. The Section reviewed and commented on several legislative bills that would affect wildlife.

9. The Section responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing, and importation of wildlife.

10. The Section responded to numerous public requests for information on native wildlife, particularly endangered species.

11. The Section answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearms regulations, hunting seasons and limits, and laws and regulations.

12. Section staff provided technical assistance to numerous farmers and the Air Force and Navy regarding pig damage. Damage control permits requests were evaluated and issued when warranted.

13. Section staff reviewed wildlife-related manuscripts for professional journals. One of our staff is an editor for the University of Guam's journal "Micronesica" and in this capacity reviewed several articles for publication.

14. Section staff assisted in presented hunter safety briefings at Anderson Air Force Base and the Mangilao Community Center to provide pertinent information to hunters.

15. Section staff made numerous presentations on fish and wildlife resources at meetings of numerous and other organizations during the year.

16. Section staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues, fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.

17. Technical assistance and logistic support was provided to various personnel from the USFWS, National Biological Survey, U.S. Department of Agriculture's Animal Damage Control working on the brown tree snake problem on Guam and in the mainland U.S.

18. The Section staff, at the request of numerous developers, met with them, their consultants and other government representatives to discuss proposed development projects and their potential impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.

19. Section staff provided technical assistance to USFWS and National Marine Fisheries Service law enforcement personnel on various matters including the importation of endangered species items.

20. Technical advice on wetland issues have been provided to the Development Review Section at the Guam Environmental Protection Agency.

21. Section staff participated in the Navy Installation Restoration Program by providing information to Navy consultants, accompanying them on several site visits, and attending public meetings.

22. Staff gave visiting lectures for various University of Guam biology classes on wildlife related topics.

23. Section staff assisted the military in planning field training exercises at various military bases on Guam so that endangered species and their habitat and other wildlife resources would be minimally impacted. Military units involved included:

    a. Guam-based Navy Seals.
    b. Guam National Guard.
    c. Various Air Force units.
    d. U.S. Army units from off-island.
    e. Air National Guard.
    f. University of Guam Army ROTC.
    g. Various DOD special operations units.
    h. U.S. Army Reserves.
    i. U.S. Navy carrier air units detached to AAFB for exercises.

24. Section staff on numerous occasions met with representatives of the press to discuss wildlife issues the media was interested in. Contact was made with the following organizations:

    a. Pacific Daily News, Guam
    b. KUAM TV News, Guam
    c. Guam Cable TV News
    d. KGTF public radio, Guam

e. K-57 radio news, Guam
f. Day One, NBC News, New York
g. National Geographic Society Television, Washington, D.C.
h. KMGH TV 4, Honolulu

25. Biologist Gary Wiles worked with Guam based USFWS staff to study aspects of the biology of island swiftlets. They performed surveys of foraging birds, trapped snakes at the main roosting cave, continued on-going work on the reproduction and roosting behavior of the birds, and examined possible causes for a large decrease in bird numbers at the main cave in February and March.

26. Section biologists participated in a nine-day survey of white-eyes on Rota. The survey was conducted in cooperation with the USFWS, Biological Resources Division, and the CNMI Division of Fish and Wildlife.

27. Section staff worked with the Air Force, USFWS, University of Guam, and Division of Forestry to erect a 6-foot-tall protective fence around the last remaining *Serianthes nelsonii* tree on Guam.

28. Wildlife staff met with members of the Committee on the Scientific Bases for Preservation of the Mariana Crow, National Research Council, National Academy of Sciences on Guam to discuss the status of and recover efforts necessary for recovery of the Mariana crow. A report will be issued early during FY '97.

RECOMMENDATIONS

Continue technical assistance activities in support of the conservation of Guam's wildlife.

PROGRAM COST

The estimated cost of the technical assistance project under W-1R-4 is $49,878.

This report was prepared by: Robert Beck

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT N0.: E-1-11
STUDY NO.: 4
JOB NO.: 1

JOB TITLE: Captive Breeding Endangered Native Birds (1480)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

The number of Guam rails at the Division of Aquatic and Wildlife Resources' (DAWR) captive breeding facility on Guam increased from 55 as of September 30, 1995 to 71 by September 30, 1996. Eight breeding pairs of rails were separated due to poor reproductive performance, most likely due to the advanced age of one partner in each pair. Four new pairs were set up for breeding for a total of five breeding pairs. However, by September 30, 1996, one of the five pairs of breeders was lost due to the death of the female. Twenty eight of 49 (57%) of hatched chicks lived for at least 30 days of age, 24 of which were eventually banded and added to the captive flock by September 30, 1996. Twenty Guam rails were transferred from the National Zoological Park, Conservation Research Center to DAWR's captive breeding facility. There were 11 adult mortalities and 2 deaths of subadult rails (just over 30 days old). Fifteen Guam rails were translocated to Rota and released. Two Mariana crow chicks were hatched and hand-reared in the DAWR's Wildlife Lab. As of September 30, 1996, there were 53 Micronesian kingfishers in captivity at mainland U.S. zoos, including 7 viable offspring hatched in FY96. However, there were more deaths (n = 9) than births.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the DAWR, member zoos of the American Association of Zoological Parks and Aquariums (now known as the American Zoo and Aquarium Association, or AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae,* and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their disappearance from the wild (DAWR 1984).

The Guam rail, *Rallus owstoni*, and Guam subspecies of the Micronesian kingfisher, *Halcyon c. cinnamomina,* were successfully brought into captivity (DAWR 1983-6), with the capture of 19 and 31 wild birds respectively. Rails first bred at the DAWR's facility on Guam and at the Conservation and Research Center (CRC) of the National Zoological Park in 1984. Dr. Scott Derrickson, Curator of Birds, CRC, continued as coordinator for AZA's Guam Rail program. By November 1996, more than 400 Guam rails were produced in captivity.

Reproduction of Mariana crows in the wild continued to be low despite intensive protection against snake predation. Consequently, avicultural intervention was initiated in FY95, and continued in FY96, to prevent complete reproductive failure among nesting Mariana crows. The program included artificial incubation of eggs, puppet rearing of chicks, and release back into the wild. The program was developed for the Mariana crow using guidelines developed for the 'Alala (*Corvus hawaiiensis*) by the Peregrine Fund (Kuehler *et al.* 1994).

Kingfishers were first bred in 1985 at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo and the CRC). During FY88, the first studbook for the Micronesian kingfisher was published by the Philadelphia Zoo (Bahner 1989). The kingfisher has been designated as a Species Survival Program species by the AZA. Beth Bahner of the Philadelphia Zoo was designated by the AZA as studbook keeper. The kingfisher program has been relatively successful, as 17 of 29 founders produced descendants (the last previously underrepresented living founder sired offspring in 1994), and the population reached a peak of 62 individuals in August 1990. However, problems such as high chick mortality, high young adult mortality, aggression, and infertility continue to limit population growth (Bahner 1993).

OBJECTIVES

1. Implement and manage captive breeding programs for the Guam Rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland U.S. through the AZA.

2. Produce enough Guam rails for release and establishment of an experimental wild population on Rota, CNMI.

3. Enhance reproductive output of Mariana crows in the wild using avicultural support.

4. Become more administratively active in the management of captive Micronesian kingfishers.

PROCEDURES

1. Design and construct seven steel framed 12-stall holding aviaries to replace existing wooden aviaries that have deteriorated from weather and typhoons. Add additional holding aviaries as the need arises.

2. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.

3. Develop techniques for the successful release of captive-reared birds in the wild once the factors responsible for their decline have been controlled.

4. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.

5. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.

6. Breed rails in sufficient numbers to support the continuing introduction of the Guam rail to Rota, Commonwealth of the Northern Mariana Islands.

7. Maintain regular contact with the Micronesian kingfisher studbook keeper, and make recommendations to the SSP.

8. Coordinate efforts between field and laboratory for manipulating nests, eggs, and chicks of Mariana crows in the wild.

RESULTS

The number of Guam rails at the DAWR's captive breeding facility on Guam increased from 55 to 78 during FY96, primarily due to the production of 22 viable offspring and the transfer of 20 rails from CRC. Fifteen rails were released on Rota in April 1996 and 13 adult rails died at the DAWR captive breeding facility. Deaths of captive rails were due primarily to old age. One adult rail escaped from a breeding pen (although it had not yet reproduced) and was considered dead, as it was never sighted or recaptured.

Approximately 43% of chicks that hatched did not survive to 30 days of age due to poor parental care and other unknown causes. Eight pairs of rails had at least one partner nine years old or older. These pairs were exhibiting poor reproductive success (low hatching rates and low chick survivorship rates), suggesting that the older partners were of post-reproductive age. A total of 12 elderly rails (nine years old and older) were culled from the breeding population and four new breeding pairs of younger birds were established. Reproductive success increased as a result of these changes.

Two staff members were added to the Guam rail program in March 1996, one Biological Aide and one intern from the Department of Public Health and Social Service's Community Work Experience Program. The Biological Aide resigned after three months. The program remained understaffed with one Technician I, one Biologist I, and one Biologist III. The intern provided by Department of Public Health continued to work through September 30, 1996.

A Humidaire incubator and hatcher were set up in the incubator room at the Wildlife lab. Nine eggs were pulled from nests of Mariana crows in the wild and were incubated at the Wildlife lab. Four eggs were fertile, and five were nonviable. Four chicks hatched with assistance, and two survived to fledging. Two eggs failed to hatch: one was a late embryo death and the other was dead in the shell after pipping began. Two crow chicks, one male and one female, were handreared and fledged in captivity. The fledglings were held in a flight aviary through September 30, 1996. Mr. Chris Eckart, from the Olinda Endangered Species Captive Breeding Facility, was detailed to DAWR from the State of Hawaii between December 21, 1995 to January 26, 1996 to assist in training DAWR staff in handrearing crows.

Micronesian kingfishers continued to be captive bred at 8 mainland U.S. zoos (reduced from 13 institutions as a result of the 1995 Action Plan). The Micronesian kingfisher population in captivity at mainland U.S. zoos declined from 55 by September 30, 1995, to 53 by September 30, 1996. Adult mortality continued to offset reproduction in FY96. Seven viable offspring were produced, but 9 adults died. Dr. Ilse Silva-Krott and colleagues including Dr. Randy Junge, the Micronesian kingfisher SSP veterinarian, received a grant from Disney (via the AZA) to conduct a study of occurrence of *Mycobacterium avium*, the agent that causes avian tuberculosis, on Guam. Pooled samples from birds (primarily poultry) in each of 21 villages on Guam were analyzed, and two tested positive for *Mycobacterium avium*. This study quelled concerns regarding the risk of introducing a new disease to Guam (avian tuberculosis) if Micronesian kingfishers are repatriated.

RECOMMENDATIONS

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.

2. Develop plans for moving the rail facility to a potential new Department of Agriculture site.

3. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.

4. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits for shipment of rails between Guam and mainland U.S. zoos.

5. Breed rails in sufficient numbers to support the continuing introduction of the Guam Rail to Rota, Commonwealth of the Northern Mariana Islands.

6. Coordinate with Dr. Scott Derrickson of the CRC the transfer of Guam rails produced in zoos to Guam for the purposes of captive breeding at the Guam facility or for release on Rota.

7. Continue avicultural intervention of Mariana crows and support efforts of DAWR to increase production of crows in the wild through efforts to snake-proof crow nest sites.

8. Initiate plans for the repatriation of Micronesian kingfishers to the captive breeding facility on Guam.

PROJECT COST

Estimated cost of this project under E-1-11 is: $174,000.

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JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-11
STUDY NO.: 4
JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam Rails in the Commonwealth of the Northern Mariana Islands (1311)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

A total of 15 Guam rails (*Rallus owstoni*) were released at the Sagua'gagha area of Rota in April 1996. Extensive efforts were made to remove predators from the release area. Eight rails were instrumented with radio transmitters. Mortality of radio-marked rails was 25% as two rails were confirmed dead. One of these deaths was caused by predation from a monitor lizard, and the other by trauma due to an apparent predation attempt by an unknown assailant. The remaining rails survived an average of 37.9 days. Five radio-marked birds either dispersed from the release area, as an exhaustive ground search was not successful in locating these birds, or their transmitters failed. There was a problem with some of the transmitters exhibiting frequency drift, which may have contributed to difficulties associated with locating lost birds. Rails moved a mean distance of 519 m away from the release site with the longest documented distance being 1,200 m. Rails used supplemental feeding stations which facilitated observation of non-radio-marked birds from blinds set near the stations. Three rails (2 non-radio-marked) were recaptured in live cat traps, which also facilitated post-release monitoring of rails. In December 1995, reproduction was documented when an adult non-radio-marked male that had been attending a food station regularly came into the station with a chick. It was estimated that this chick was 3-4 weeks old, based on plumage characteristics. This same chick and the adult male were captured about a month later in a live cat trap near the same area. The young bird has not been seen since then, but the adult male was seen in the area as late as August 1996, 11 months post-release. One radio-marked rail has established and maintained a territory below the bird sanctuary overlook at Puntan Sagua'gahga since May 1996 and was still there as of 30 September. This may be a reasonable area to release a small group of rails in the future as it is naturally isolated and may help in decreasing dispersal of the birds.

INTRODUCTION

Census data collected between 1960 and the early 1980s documented the reduction in range and numbers of the Guam rail (Witteman *et al.* 1990). In 1984, the Guam rail was listed on the U.S. Endangered Species List. About 20 rails were known to remain in the wild. In 1982, it was decided to develop a captive breeding program for the rail and by 1986, 21 birds had been collected from the wild. The extirpation of the Guam rail from the wild was due primarily to predation by the introduced brown tree snake (*Boiga irregularis*) (Savidge 1986, 1987; Conry 1988). The captive propagation program was organized under the auspices of the American Association of Zoological Parks & Aquariums (now the American Zoo & Aquarium Association or AZA) and includes the cooperation of approximately 18 mainland zoos. The rails demonstrated an immediate propensity for breeding in captivity

and to date over 400 rails have been produced in captivity (Derrickson 1996). The captive management of the Guam rail uses the metapopulaton approach, which calls for the establishment of more than one subpopulation (Foose *et al.* 1986). This has been accomplished by dispersing the captive rails into two primary captive populations on Guam and in U.S. zoos. Because reintroduction of the Guam rail to part of its historical range on Guam is a recovery objective, the establishment of an experimental wild population was proposed (U.S. Fish & Wildlife Service, 1989), not only to serve as a third subpopulation to prevent genetic drift and inbreeding, but to ensure the maintenance of behavioral adaptations for the wild. Further, it has been demonstrated that reintroductions of captive produced animals are less likely to succeed than translocations of wild-caught animals because of behavioral deficits (Griffith et al. 1989). Therefore, if rails can be established in the wild now, it will facilitate the reintroduction of rails to snake-free areas on Guam in the future, when such areas are designated, via wild to wild translocations. Finally, experience gained in releasing Guam rails on Rota will provide valuable information useful for future reintroductions on Guam.

OBJECTIVES

1. Establish a non-essential, experimental wild population of the Guam rail in suitable snake-free habitat on Rota, CNMI.

2. Produce rails at the captive propagation facility of Guam's Division of Aquatic and Wildlife Resources (DAWR) for release on Rota.

3. Translocate rails from the captive propagation facilities at cooperative mainland zoos to Guam for release on Rota.

4. Monitor survival, dispersal, reproduction and establishment of released rails through radio telemetry.

5. Identify and eliminate or control factors limiting establishment of rails in the wild on Rota.

PROJECT HISTORY

During FY87, a cooperative agreement was signed between the Government of Guam, Commonwealth of the Northern Mariana Islands (CNMI), and the U.S. Fish and Wildlife Service (USFWS) outlining the responsibilities of each entity for the introduction. An environmental assessment was prepared for the USFWS covering the introduction of the Guam rail to Rota. An informal agreement was reached with Dr. Stuart Pimm, University of Tennessee, by which a graduate student resided on Rota to monitor the initial two rail introductions in cooperation with the DAWR as a part of his dissertation research. Dr. Pimm was successful in receiving several grants from international conservation organizations to support his efforts in monitoring the introduction on Rota. After the final rule to establish an "experimental population" of Guam rails from the captive population was published by the USFWS in the Federal Register (USFWS 1989), 22 Guam rails were released at the first site on the sabana on Rota in December 1989 and January 1990. This release was considered less than successful as there was a high level of mortality and rails failed to penetrate the forest as was expected (DAWR 1991, Witteman *et. al.* 1991). The forest edge of Puntan Sagua'gahga in I Chiugai was chosen as the site for the second release of Guam rails on Rota. On February 4, 1991, 31 rails were released at the forest edge in I Chenchon Park near the Bird Sanctuary Overlook (Witteman and Beck 1991). This release appeared to be more successful than the first release at the sabana, as more rails survived for longer periods of time, and some showed fidelity to the new release site.

Graduate student Greg Witteman returned to the University of Tennessee in the spring of 1991 after the second release to complete his graduate work. Releases were discontinued until the spring of 1995, when 60 Guam rails were released deeper in the forest of Sagua'gagha (DAWR 1995). Extensive efforts were made to remove predators from the release area after experiencing heavy predation of the first fifteen birds released in March 1995, resulting in a reduction of predation and an increase in survivorship of birds subsequently released (DAWR 1995). Guam rails were known to be surviving in the release area through September 30, 1995. Other information derived from the FY95 releases included dispersal, behavior, and other factors contributing to mortality (DAWR 1995). Releases continued in FY96, with the release of only one small group of Guam rails.

METHODS

Study Site Description

I Chiugai is a coastal limestone cliff area located on the eastern end of Rota. The release area is nearly 1 square km (approximately 97 ha) in area, two thirds of which is a narrow band of good quality native forest bound by upper and lower limestone cliffs. The surrounding area is a mixture of native forest pockets, scrub (secondary growth), and clearings with coconut plantings. A trail approximately 2 km long dissects the Puntan Saugua'gahga and Puntan As Fani forests, two relatively broad geographical points connected by a narrow corridor (about 60,000 m^2) of contiguous forest. The Guam rail introduction cages are situated in the corridor of forest between the two points, which is designated as the release site.

Predator Control

Beginning in June 1995 and continuing through September 30, 1996, as many as 27 live-capture traps for cats were set along the trail in the release area and the adjacent I Chenchon park to control feral cat (*Felis cattus*) and monitor lizard (*Varanus indicus*) populations. The number of traps set varied due to some of the traps being periodically stolen and replaced at the I Chenchon park area. In January 1996, all traps were moved into the Sagua'gagha area on the main trail to reduce the chances of trap theft. Cat traps were placed 100 m apart for a distance of 2 km along the trail. Numerous traps were also placed 50-100 m off to the sides of the main trail. Canned cat food or dead rats (see below) were used as bait. Traps were set for capture all day as monitor lizards (diurnal animals) were also targeted for capture. Following capture, cats and monitor lizards were dispatched with a pellet gun, weighed, measured, classified to age and sex, and dissected to examine gut contents (primarily for evidence of rails). Traps were closed between December 6, 1995 and January 5, 1996 due to limited DAWR manpower, but between January 6 and March 28, 1996, volunteers provided by the USFWS resumed operation of the cat traps.

The roof rat (*Rattus rattus*) was also previously identified as a potential predator of rail nests (DAWR 1994). Between October 3, 1995 and November 15, 1995, 25 kill traps and 16 live traps were placed 25 m apart along the main trail, either on the ground or on a tree trunk 1-2 m above the ground. Rats captured in live traps were dispatched with a pellet gun then used with other rats captured in kill traps as bait in the live cat traps. Fresh coconut dipped in peanut butter was used as rat bait. Rat trapping was discontinued between November 16, 1995 through March 28, 1996 due to limited manpower on Rota. When trapping resumed in April, 1996, a 125 m x 150 m grid consisting of 58 kill traps set 25 m apart was set up around the release site. The grid was established to reduce rats around the introduction cages and in the immediate vicinity in case rails attempted nesting in the area. In August 1995, it was apparent that two pairs of rails had formed potential

breeding bonds and may have attempted to nest approximately 50 m from the introduction cages (DAWR 1995). Grid trapping ceased in June 1996, as there was no apparent rail activity in the area. All rats captured were identified weighed, measured, and classified to age and sex.

Release Methodology

Fifteen introduction cages, 4' W x 4' L x 2' H were lined up along the trail at the introduction site. The cages were about 3-4 feet apart, and were made of 1.5" x 1.5" wood and 1/4" mesh hardware cloth. Each cage was bottomless and sat flush to the ground with rocks, dirt, and leaf litter piled around the perimeter to keep predators out. A small wire door was on the top of the cage for placement of the rails, food, and water inside. Guam rails arrived on Rota two days prior to release via commercial airplane. The birds were transferred to the introduction cages (one bird per cage) and held for two days to acclimate to the sights and sounds of the forest. Fifteen rails (7 males, 8 females) were released on 17 April 1996. The rails were released from the cages by lifting the introduction cage and letting the bird run or walk out. All birds had a unique combination of color coded bands on the left leg and serially numbered aluminum bands on the right leg.

Radiotelemetry

Eight rails (4 males, 4 females) were equipped with backpack mounted radio transmitters (AVM, Inc.). Radio-marked birds were relocated using a Telonics TR-2 portable receiver/scanner and a hand-held antenna. Very general locations of radio-marked rails were recorded according to the station (every 25 m along the main trail) to which they were the closest. If rails dispersed out of the release area and away from the trail, general topographical and geological features were used to describe the bird's location. Birds were never flushed in order to not disturb any potential nesting pairs and/or broods and to not drive the birds from the release area. An attempt was made to locate each individual twice per day: one location from 0600-1200 and another from 1201-1800. Data was collected on survivorship, mortality, and dispersal. Mortality signals in transmitters allowed rails to be picked up usually within 12-24 hours of death. Remains of dead rails were examined for signs of cause of death. Whole carcasses were returned to Guam for necropsy.

Supplemental Feeding

Supplemental food stations were set up around the introduction cages and in the release area in an attempt to get the rails to stay in the release area. The food (captive diet) was presented in the same manner on Rota as it was in captivity on Guam. Every morning fresh food was put in a plastic dish under a tent of aluminum and wood to protect it from rain. In the evening the food was removed to prevent rats from habituating to this food source. Once it was determined that a station was being utilized, a temporary blind was placed near the station to determine if rails were using the supplemental food, and to observe the leg bands so the bird could be identified. Feeding behaviors were recorded as well. Supplemental feeding continued as long as it was apparent that rails were utilizing the food stations. Supplemental feeding was discontinued between releases (i.e., December 1995 through March 1996), when it appeared that only rats were taking the food.

RESULTS

Predator Control

A total of 231 rats were captured during 1,603 trap nights (14.41 rats/100 trap nights) for the entire fiscal year. From April 16 - June 26, a total of 121 rats were captured in 1,307

trap nights (25.21 rats/100 trap nights) on the 58 trap grid in the release area. Figure 1 shows the daily number of rats captured per 100 trap nights during this period (April 16 - June 26). A total of 10 cats (5 male, 5 female) and 10 monitor lizards were trapped during 2,562 trap nights for the fiscal year (3.9 cats/1000 trap nights).

Figure 2. Guam rails were released from introduction cages by lifting the bottom and allowing the rails to run or walk out into the forest.

Mortality, Survival, and Dispersal

Two of the 8 radio-marked Guam rails were found dead within 13 days of release. The partial remains of one rail was found under a rock, apparently scavenged by a monitor lizard. The other rail was returned for necropsy, which indicated the rail was not foraging adequately (was nutritionally stressed), but that the cause of death was trauma to the head by an apparent predation attempt. Contact with 3 signals was lost within 2 days post-release, and with another within 2 days post-release. The latter bird was found alive 25 days later, when its signal was picked up approximately 1 km west of the release site near the I Chenchon park. Over the course of the next 15 days, the rail moved an additional 200 m west along the 2-track road and settled in a narrow strip of forest on the south side of the road. Radio contact with this bird was finally lost on May 29, 42 days post-release. Another bird remained within 300 m west of the release site for 75 days and was seen on numerous occasions to utilize one of the supplemental food stations in the area. One non-radio-marked rail from the September 1995 release was resighted in June 1996 at a food station approximately 250 m west of the release site. After apparently becoming wary of the observer in the blind near the food station, this rail was last seen on August 6, 1996, 322 days post-release.

The mean number of days that radio-marked birds released in April survived before the signal was lost or the birds died was 37.9 (range 1-166). One radio-marked rail was still alive through September 30, 166 days post-release (Table 1), and established a territory below the bird sanctuary overlook at Puntan Sagua'gahga. The mean distance that rails moved from the release site before the signal was lost, they died, or they established a territory was 518.8 m (range 75-1,200 m).

Supplemental Feeding and Behavior

More than 180 hours were spent observing food stations from blinds. As many as 5 feeding stations were used by 5 different rails (radio-marked and non-radio-marked), as confirmed by visual observations or the presence of rail footprints in the food. Supplemental feeding continued as long as it was apparent that Guam rails were continuing to return to food stations. One rail (a non-radio-marked adult male released in September 1995) was seen attending two adjacent food stations 75-100 m west of the release site on an almost daily basis from early October through early December 1995. Another rail (a non-radio-marked adult female apparently from the September 1995 release) was also seen coming to these stations during late October and early November. On December 6, 1995, the adult male was seen at both of these stations with a downy chick estimated to be approximately 3-4 weeks old. This significant observation marked the first record of rails breeding on Rota, and the first recorded breeding in the wild since rails were rescued from extinction on Guam in the 1980s. The male and the chick were later caught in a live cat trap near the food station on January 1996. The chick's primary feathers were fully erupted and the secondary feathers were partially erupted. It was estimated to be 7-8 weeks old. Both birds seemed in good health at the time of their capture and were immediately released from the trap.

On December 7, 1995, the day after the chick was first seen with the adult male, the adult rails began making a series of short, brief alarm calls on the trail near the food stations. The male was flaring out its wings in a threatening posture, and was charging a 1 m long monitor lizard that was approaching the food station on the trail. The rail repeatedly rushed the lizard while making alarm calls and flaring its wings. Meanwhile, the female rail was seen briefly on the side of the trail at the beginning of the incident, disappearing immediately afterward. There was no sign of the chick. The lizard eventually crossed to the other side of the trail with the male following and continuing to call. The frequency of calling faded, but continued for at least 30 minutes, 50-100 m south of where the incident began.

Two radio-marked rails released in April 1996 were seen regularly at supplemental food stations approximately 200-250 m west of the release site, and 300 m southeast of the release site. Visual and radio contact with both birds was subsequently lost 75-90 days after release.

DISCUSSION and CONCLUSION

Cat trapping efforts increased in 1996 with 2,562 trap nights compared to 1,145 trap nights in 1995, but the rate of capture dropped (7.86 cats/1000 trap nights in 1995 vs. 3.90 cats/1000 trap nights in 1996). The drop in capture rate and the lack of confirmed deaths of rails attributed to feral cat predation in 1996 may be an indication that trapping is an efficient means to control these predators in the release area. However, the capture and predation statistics may also indicate that cats remained in the area, but were not getting caught or preying on rails. A study of feral cat predation on birds in New Zealand revealed that only some cats were responsible for killing, while other cats, although present in the area did not prey on the bird species of interest to wildlife managers. Although there were no deaths directly attributable to feral cat predation in 1996, it is still advisable to continue trapping. There has been no direct evidence that monitor lizards preyed on adult rails, chicks, or eggs, however, they may pose a threat to nesting rails as evidenced by the interaction between the adult rails and the passing monitor in December 1995. Therefore, continued removal of monitor lizards from the release area is advisable. The data indicated that it may be possible to reduce rat populations in a localized area by use of kill traps set in a grid (Fig. 1). This seemed successful in reducing rat numbers in the immediate release

area, but there is no direct evidence to show that rats have preyed on rail nests or chicks. Maintenance and data collection associated with traversing the trap grid may in fact disturbed rails in the area of the grid.

Survivorship of released rails did not appear to be affected by dispersal distance, as one bird lived 166+ days and settled more than 900 m from the release site while another lived 300+ days within 200 m of the release site. In contrast, pair formation and reproduction rate may be dependent on dispersal distance; decreasing as dispersal distance increases. The only documented reproduction occurred within 100 m of the release site. The likelihood of rails encountering each other may have been lower the further the rails moved away from the release site. With the small number of birds available for releases, control over dispersal may be necessary. This might be accomplished by releasing rails in an area where dispersal is difficult, yet chances for survival are good, or constructing a barrier in the current release area to limit dispersal of birds. Further, releasing paired birds, as opposed to singletons, may also help to increase the chances for successful reproduction.

Survivorship or successful foraging did not appear to be dependent on supplemental feeding, as many rails that moved away from the release site lived as long or short as rails who stayed in the release area and used supplemental food stations. Further, it is unknown how many rails that remained in the release area did not use supplemental food stations. Supplemental food stations may have played more of a role in defining (or defending) territories than in factors related to survivorship. There appeared to be no significant differences in dispersal pattern or survivorship between the sexes, although all radio marked females were dead or their signals lost within 13 days post-release (Table 1). The high number of lost transmitter signals may be attributed to frequency drift and possible subsequent radio failure. Some of the drift was so extreme that overlap occurred between frequencies, making identification of individual radio-marked rails impossible. It may be advisable to switch transmitter suppliers or look for ways to improve the reliability of the transmitters. Some lost signals may also be attributed to birds dispersing so far into inaccessible areas that the chances of finding them were significantly reduced by ground searching. Periodic aerial surveys should be conducted in order to locate birds that have dispersed far from the release area or into areas inaccessible by foot. In addition, equipping all birds with transmitters would help gather more data on survival, mortality, dispersal, and reproduction.

RECOMMENDATIONS

1. Continue to trap and remove feral cats and monitor lizards from the Sagua'gahga forest and surrounding areas.

2. Control rat populations by using kill traps in the immediate release area at least 1 month prior to release, but discontinue trapping once birds are released.

3. Attach radio transmitters to all released birds.

4. Investigate the feasibility of constructing a temporary, large scale, enclosure at the present release site to reduce widespread dispersal of rails.

5. Investigate the possibility of releasing rails in an area where dispersal may be limited.

6. Continue to release cohorts of 15-20 birds minimum, every 3-6 months until the birds become established. Attempt to release at least one mated pair in each cohort.

7. Use aerial surveys to find radio-marked birds that may have dispersed from the release area.

8. Continue the use of supplemental feeding stations.

9. Improve present radio transmitters and investigate alternative radio transmitter suppliers.

ACKNOWLEDGMENTS

The staff of the Department of Lands and Natural Resources, Division of Fish and Wildlife (DFW) on Saipan assisted with many administrative details such as issuing the permit for research on Rota, and for obtaining all required import permits to translocate Guam rails to Rota. Dr. Ann Marshall, DFW, also assisted with fieldwork on Rota. The DFW staff on Rota were extremely helpful in supplying manpower and vehicles. Conservation officers on Rota assisted in carrying the rails into the forest. Division biologists David Worthington and Stan Taisacan assisted in various aspects of the program, including transportation and office support. USFWS biologist, Daniel Grout, provided communication services between Rota and Guam and assisted with monitoring released rails. Rota resident, Jeremy Bowman, assisted in monitoring released rails and running trap lines.

PROGRAM COSTS

The estimated cost for this project under E-1-11 is $ 50,000.

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This report was prepared by: Grant M. Beauprez and M. Kelly Brock.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-11
STUDY NO.: 7
JOB NO.: 3

JOB TITLE: Development and Testing of Control Methods for Enhancing Reproduction Affected Endangered Native Forest Birds and Fruit Bats (1470)

PERIOD COVERED: October 1, 1995 to September 30, 1996

SUMMARY

Field tests of electrical barriers designed to prevent predation on Mariana crow (*Corvus kubaryi*) nests by brown tree snakes (*Boiga irregularis*) continued this fiscal year. Unprecedented crow nest site fidelity was documented this season. Three clutches were laid sequentially in one nest. Five active crow nests were snake-proofed. As a result of snake-proofing of active crow nests early in the nest building phase, 3-egg clutches were recorded for a fifth year, as well as 1- and 2-egg clutches.

BACKGROUND

Roadside counts by the Guam Division of Aquatic and Wildlife Resources (DAWR) have documented the decline of the native forest birds of Guam (DAWR 1974-1988). Studies by Conry (1988) and Savidge (1987) have indicated that predation by brown tree snake is the main cause of this decline.

Since these studies, attempts to develop effective means of protecting active nests of Mariana crows have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of the adhesive resin Tangle-Foot ® have all been used as snake barriers around nest trees. The use of sheet metal girdles and Tangle-Foot was partially successful but resulted in the mortality of nest trees and was discontinued. One fledgling was fledged from a nest in 1989 as a result of Tangle-Foot protection.

Since 1990, active nests have been protected successfully with the use of a combination of electrical barriers placed on the trunks of active nest trees and clearing of vegetation around the tree (Aguon et al. 1992). Successful protection of active nests resulted in the fledging of three crows from two nests in 1992 (DAWR 1992) and two from two nests in 1994 (DAWR 1994). These were the first fledglings in the wild since 1985 (Michael 1987), with the exception of the one produced as a result of Tangle-Foot protection in 1989.

OBJECTIVES

To develop methods for controlling snake predation on active nests of native birds.

PROCEDURES

1. Develop methods for snake-proofing active native forest bird nest sites.

2. Implement snake-proofing methods at Mariana crow nest sites.

RESULTS

Field use of electrical barriers to protect the nests of Mariana crows from brown tree snake and monitor lizard (*Varanus indicus*) predation continued this fiscal year. Electrification of nest trees prior to egg laying continues to be important for protecting crow nests.

During the crow-breeding season from about November 1995 to March 1996, intensive searches were carried out in northern Guam to locate crow territories and nest sites. Barriers were placed on nest trees during the night as soon as nest building was observed. Battery-powered electrical barriers equipped with solar panels were used. Maintenance of the barriers was conducted throughout the nesting season. Trapping for snakes occurred around and in nest trees. Care and feeding of the mice used as bait in traps occurred during darkness, usually before sunrise.

Three active Mariana crow nest trees used by 3 pairs of crows were snake-proofed. Two pairs exhibited unprecedented nest site fidelity by laying sequential clutches of eggs in the same nests, which eliminated the necessity to install barriers on different trees as the crows renested. Two snakes were caught in one of the nest trees as the barrier was being installed prior to the first clutch being laid. This pair eventually laid 3 clutches of eggs in the same nest. Unfortunately, after the last clutch was laid, the male failed to return to the nest one day and is believed dead.

Only one other pair produced eggs during the season. When their nest was first found, eggshell fragments were found on the forest floor and probably belonged to the first clutch of this pair. The egg was laid and lost before the nest could be protected with a barrier. The second clutch at the same nest site was protected, but only one egg was laid. After 10 days of natural incubation, the egg was removed from the nest. Though given seven additional days of artificial incubation, embryonic development was not detected.

The third Mariana crow pair failed to lay eggs. This pair has failed to lay any eggs for at least the past 5 breeding seasons. The typical nesting pattern of this pair has been to construct a nest and abandon it when it is completed. This season a dummy egg was placed in their nest when nest attendance was waning and the birds were probably going to abandon. Nest attendance increased from less than 10 % to 70% the day after the egg was placed in the nest, but diminished after a week.

In summary, during the 1995-1996 breeding season, two pairs of crows produced 4 clutches totaling 9 eggs. Of the 9 eggs, 4 (44%) were infertile (i.e., no embryonic development ensued) and 5 (56%) were fertile (Table 1). Only one pair of crows, located in the Conventional Weapons Storage Area, produced fertile eggs. Two chicks hatched with assistance and fledged successfully into captivity and 3 died before hatching or soon after hatching (Table 2). All hatched chicks needed assistance because pipping ceased when only 2/3 to 3/4 completed or the yolk sac was unretracted. These problems may indicate that artificial incubation conditions developed for *C. hawaiiensis*, which are being used for the Mariana crow, may differ slightly from those required by the Mariana crow.

Although snake-proofing has greatly reduced predation, other additional factors appear to be limiting reproductive success in Guam's Mariana crows. Low hatching rates were again documented this year. Nest disturbances by intruder crows were noted at one of the five nests. It is recommended that other management techniques be implemented (e.g., translocation of fertile eggs or nestlings from Rota) to improve the reproductive success of these birds.

Table 1. Summary of nests protected with electrical barriers and their outcome. Note that 318a,b, and c are from the same nest but are sequentially laid clutches. Eggs were usually candled after the first week of the incubation period. The number of snakes is the number caught during barrier installation.

Pair ID	Nest No.	Tree Species	No. of Snakes	Clutch Size	No. Hatched	Percent Hatched
C1	318a	Elaeocarpus	2	3	0	0.00
C1	318b	Elaeocarpus	0	2	1	0.50
C1	318c	Elaeocarpus	0	3	1	0.33
11B6	320	Elaeocarpus	0	1	0	0.0
WSA	308[1]	Ficus	0	0	0	0.0

[1]These nests were snake-proofed when nest attendance was diminishing. A dummy egg was placed in the nest.

Table 2. Summary of the outcome of eggs, which were removed from Mariana crow nests during the 1995-1996 breeding season. Eggs are identified by an alpha-numeric code indicating breeding pair location, clutch number, egg sequence in clutch, and breeding season (i.e., (C1) breeding pair, (1) first clutch (a) egg in clutch, (95/96) breeding season).

Egg I.D.	No. Days Natural Incubation	Viability	Hatch Success	Outcome	Problems
C1-1a-95/96	6	Fertile	Hatched	Died	Assisted Hatch Malposition Unretracted Yolk Sac
C1-1b-95/96	4	Infertile	Nonhatch		Unknown
C1-1c-95/96	2	Fertile	Nonhatch	Late Embryonic Death	Unknown
C1-2a-95/96	12	Fertile	Nonhatch	Dead In Shell	Malpositioned
C1-2b-95/96	10	Fertile	Hatched	Fledged	Assisted Hatch Partial Unretracted Yolk Sac
C1-3a-95/96	0	Infertile	Nonhatch		Unknown
C1-3b-95/96	1?	Fertile	Hatched	Fledged	Assisted Hatch Partial Unretracted Yolk Sac
C1-3c-95/96	0	Infertile	Nonhatch		Unknown
11B6-2-95/96	10	Infertile	Nonhatch		Unknown

The USFWS assisted DAWR this fiscal year by providing experienced volunteer staff, who helped by watching crow nests and hand rearing crow chicks.

A review of the Mariana crow recovery program was recently completed by a select committee appointed by the National Research Council, National Academy of Science, under commission by the USFWS (NRC 1996). Its recommendations included releasing on Guam all Mariana crows currently held in captivity at mainland zoos to help recovery efforts. Of the 12 crows eligible for release in the 1996-1997 breeding season, two (a male and female) are at the DAWR breeding facility, three pairs and one female are at the Conservation Research Center, National Zoological Park, and a pair and a female are at the Houston Zoo. Transfer of these birds to Guam is contingent upon approval by the Secretary of the Department of Land and Natural Resources, CNMI.

RECOMMENDATIONS

1. Continue laboratory tests of possible means of protecting active native bird nests.

2. Conduct *in situ* tests of methods which prove effective in laboratory experiments on actual active nest trees.

3. Explore and implement other methods or techniques to improve reproductive success of nesting birds.

4. Implement recommendations by the National Research Council for the recovery of the Mariana crow on Guam and Rota.

PROGRAM COSTS

The estimated cost for this project under E-1-11 is $100,000.

LITERATURE CITED

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ANNUAL REPORT
LAW ENFORCEMENT SECTION

PERIOD COVERED: 1 October, 1995 to 30 September, 1996

During the FY96, eighty-one persons were arrested and charged for violating Fish, Game, Forestry and Conservation Laws. Of the following arrests and charges: Seventy-five, including one male minor, were charged with illegal hunting; six, including three male minors, were charged with harvesting undersized coconut crabs; and two individuals, were arrested and charged for violating the Endangered Species Act of Guam by possessing a sea turtle.

A total of five individuals, (on charges not related to fish and game law) were arrested in FY96 including: Two for unlawful discharge of a firearm and three for possession of a controlled substance.

Eighty-six arrest cases have been turned over to the Attorney General's Prosecution office for criminal action. To this date, no criminal judgments have been forwarded to the Department since the beginning of FY96.

During FY96, a firearm injury resulted when an illegal hunter claimed that while he was climbing a tree, a branch broke and the 12-ga. shotgun hit the ground, triggering the weapon and shooting him in the abdomen area. He recovered from his injuries and was later charged with illegal hunting.

Of the seventy-five illegal hunting cases, several individuals were additionally charged as follows: Seven for possession of a weapon without a valid firearms identification card; one for unlawful transfer of a firearm; one for failure to report a stolen weapon; two for resisting arrest; two for contributing to the delinquency of a minor; six for hindering apprehension; six for official misconduct (three GPD officers, one GPA employee and two PUAG employees); and one for theft by receiving stolen property.

At the end of the reporting period, fourteen vehicles used in the commission of illegal hunting were confiscated and later the following occurred: Four vehicles were returned to their owners; one to an individual who had been victimized, and three to Government of Guam agencies. The Government of Guam vehicles included one GPD under cover vehicle and two PUAG official vehicles. Six vehicles were released administratively through the mitigation/remission process, with the assistance of Attorney General's Civil Litigation office, resulting in the total payment of $3000, to the Department's Wildlife Conservation Fund; Five vehicles are still pending civil forfeiture action.

Numerous incidents, such as spotlighting, fish poisoning, fruitbat poaching and turtle hunting were investigated by Conservation Officers (COs) but did not result in arrests. In some cases the lack of adequate equipment hindered the officer in making apprehension. Some incidents could not be pursued because suspects were no longer in the area. In some cases COs confronted suspects, but made no arrests due to insufficient evidence; warnings were issued where appropriate. COs removed and properly disposed of several thousand feet of abandoned gill nets in reef and beach areas. Field investigation reports of such incidents were submitted and filed for future reference.

Report was prepared by: Lt. Wayne W. Bigler